HYGIENE BY EXPERIMENT

GREGG

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A SERIES OF PROBLEM STUDIES IN HYGIENE, FOR PUPILS IN INTERMEDIATE GRADES AND IN JUNIOR HIGH SCHOOLS

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Hygiene by Experiment is the outgrowth of work in the classroom. It consists of a series of live studies which require observation and investigation on the part of the pupil. The point of view is that of nature study, and the method is essentially the project method. Every experiment and every study has been tried in numerous schools, under Professor Gregg's supervision. The results have been good, and the method commends itself to the modern teacher. World Book Company takes pleasure in presenting this text of a new type in the study of hygiene, confident that it deserves its place among "Books that apply the world's knowledge to the world's needs"

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PREFACE

During the generation or more that the subject of physiology and hygiene has been required in the courses of study in our public schools, three points have been made clear, as follows:

1. That we need to lay increasing emphasis on hygiene and sanitation and less on physiology and anatomy.

2. That our aim must be to develop boys and girls who are not only intelligent but also physically fit.

3. That our methods must be made more effective.

This textbook seeks to further the purposes that these three points indicate. It is the outgrowth of a good many years of experimentation with teaching methods in elementary hygiene in the training schools of the Peru, Nebraska, State Teachers College and of the Teachers College of Nebraska Wesleyan University. Its immediate predecessor has been the author's manual for teachers, entitled *Hygiene as Nature Study*. It seeks to give the pupil:

First, the necessary motivation for the study of the subject through appeal to his normal interests;

Second, the necessary sense experience by which to interpret the terms of the printed page; and

Third, the necessary stimulus to guarantee the fixing of proper health habits.

CONTENTS

PART THREE

Personal Hygiene: Physiology

A TALK WITH THE TEACHER

In the following studies in hygiene, Part One is designed for use in Grade 5 or 6; Part Two, for Grade 6, 7, or 8; and Part Three for Grade 7, 8, or 9. The work in each of these parts may readily be made to occupy a half year of school time. The work can be given on successive days through a half year of school, or it can be taken up on alternate days or weeks throughout the year. Many teachers prefer the latter arrangement, since it gives a longer opportunity to help fix the health habits that it is desired to set up.

It is the conviction of the author that every major and even minor topic in the subject of hygiene for the elementary grades should be approached through concrete observation and experiment by the pupil. These concrete studies can then be followed up by as much further book work as time and resources will permit. The vital point to remember is that the experiments and observations are to be done *before* and not *after* the other readings.

It should be said with a good deal of emphasis that, to insure the most satisfactory results, the teacher needs to keep looking well ahead so as to start the assembling of materials for the successful execution of the studies that are to follow in the work with the class. Just a little attention of this kind will fortify the teacher against embarrassments that always come from neglect of details.

The teacher should plan from the very first to give her pupils opportunity to provide as many of the experimental materials as possible and to assist in the experiments. This at once increases the pupils' interest and decreases the teacher's labor. How much of the work of any experimental study shall be done by the pupils

individually, and how much shall be done as a class *demonstration*, will be determined according to conditions in the individual school.

While Parts One, Two, and Three of these studies have been prepared to be used with Ritchie-Caldwell's *Primer of Hygiene*, Ritchie's *Primer of Sanitation*, and Ritchie's *Primer of Physiology*, respectively, any other authorities on the successive topics may be utilized. Indeed, a number of such authorities may well be employed, and the hygiene work can be carried on under the plan of the socialized recitation. On pages 321–324 are lists of reference sources, and the list of materials needed for the course is given in Appendix D.

Study carefully the matter contained in the Appendixes at the back of the book. The suggestions these contain will help in solving your most important problem, *that of getting boys and girls to put into practice the principles that are fundamental to good health.*

PART ONE

Habit Hygiene

A WORD WITH THE BOYS AND GIRLS

Fig. 1. A morning inspection. The inspector for the day is the pupil who had the best record for cleanliness on the preceding day. In this school, if a pupil is not clean when he comes to school, he is sent to the school lavatory to wash himself.

In parts of Europe it used to be the custom for a grandmother on Christmas morning to give out to the little girls of the household a big ball of yarn, called a "wonder ball." What really made the ball big was not so much the yarn with which it was wound, as the number of Christmas presents hidden within it.

In making up the ball the very finest present was placed at the center. After this had been wound over with yarn, other presents of less value were wound in at intervals, and the least attractive present of all was covered

with yarn at the last. But there was something about this Christmas gift that made it different from gifts as we know them, for each girl who received a wonder ball was expected to knit stockings from the yarn and to uncover the presents one by one as she knitted.

To some young people such a gift as the wonder ball might not seem very desirable, because of the work and the delay in getting at the presents. But the girl who received a wonder ball gained a great deal in the mastery of a useful art and had the fun of uncovering surprising presents of increasing value until the best present of all at last lay before her wide-open eyes.

In the little book you are now to study, you are to have experiences somewhat like that of the child with a wonder ball, for you are to learn how to do a great many different things, and each time you do what you are told to do, a surprising result will follow. Not only will you learn many of the arts and habits that will keep your bodies strong and well, but you will be rewarded with new knowledge about many things. In the end there will come to you the richest of all gifts to mankind — bodies that are robust and vigorous, and that are capable of performing the many acts necessary to make life wonderfully worth while.

STUDY ONE

TAKING A MEASUREMENT OF YOURSELF

THE Greeks who lived some 2000 years ago were a people who took great pride in having strong, beautiful bodies. You may have seen copies of statues of their great men and noted what fine-looking people the Greeks must have been. One of the rather numerous gods and goddesses that they worshiped was called *Hy-ge'ia*, the

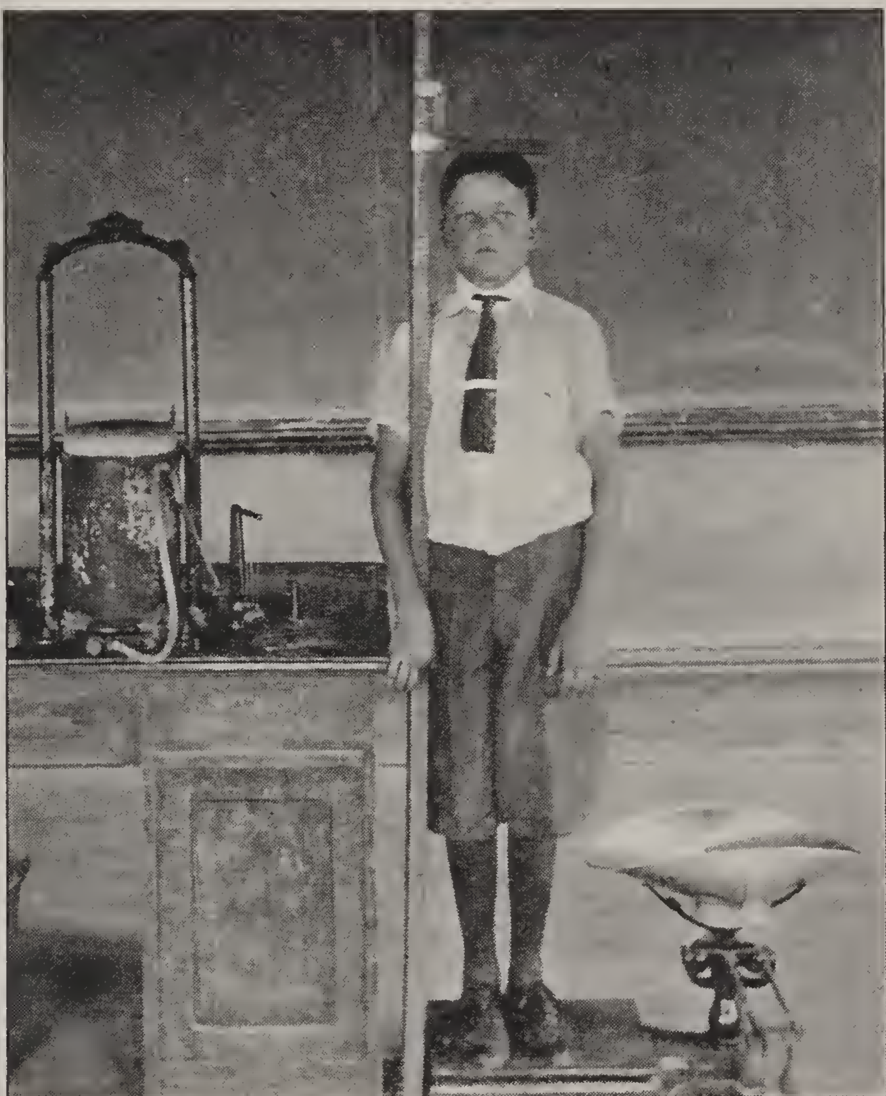


FIG. 2. Taking the physical measurements of a boy at school. The tape is in place for measurement of the chest, and a lung tester stands ready for use.

Goddess of Health. The word "hygiene" comes from the Greek word for "healthful." You are about to take up the study of hygiene, *a subject which teaches how to keep the body strong and well.*

Your first study is to be of yourself, so that you can begin to practice one of the first maxims of the wise and strong Greeks, "Know thyself." With the teacher, you will have to work out the best plan for taking these measurements. But be sure to take them very accurately, for a good many of the measurements you will want to take later on, some of them as often as once a month, just to see how much growth you can make.

Exercise I. Getting Your Measurements

1. The key to the table.

A. What is your height in inches?

B. What is your weight in pounds?

2. What to measure. (*Note.* In the table below insert only those measurements called for in Exercise II.)

	YOUR RECORD	STANDARD FOR YOUR BUILD	PLUS CREDITS	MINUS CREDITS
A. Weight in pounds.	. . . .	. . . .	. . . .	. . . .
B. Shoulder girth. . . . . (taken at biggest part)	. . . .	. . . .	. . . .	. . . .
C. Girth of relaxed right arm. . . (at middle of upper arm)	. . . .	. . . .	. . . .	. . . .
D. Girth of contracted right arm (upper arm as big as possible)				
E. Right arm expansion . . . . (difference in preceding two)	. . . .	. . . .	. . . .	. . . .
F. Girth of relaxed left arm. . . . (at middle of upper arm)	. . . .	. . . .	. . . .	. . . .
G. Girth of contracted left arm (upper arm as big as possible)	. . . .	. . . .	. . . .	. . . .

	YOUR RECORD	STANDARD FOR YOUR BUILD	PLUS CREDITS	MINUS CREDITS
H. Left arm expansion (difference in preceding two)	....	....	....	....
I. Waist girth (at smallest place)	....	....	....	....
J. Hip girth (at biggest place)	....	....	....	....
K. Right thigh girth (biggest place, standing)	....	....	....	....
L. Left thigh girth (biggest place, standing)	....	....	....	....
M. Average thigh girth	....	....	....	....
N. Right calf girth (biggest place, standing)	....	....	....	....
O. Left calf, standing (biggest place, standing)	....	....	....	....
P. Average calf girth	....	....	....	....
Q. Girth of neck, lower half	....	....	....	....
R. Girth of expanded chest (a little below armpits)	....	....	....	....
S. Girth of contracted chest (a little below armpits)	....	....	....	....
T. Chest expansion (difference in preceding two)	....	....	....	....
U. Total lung capacity (spirometer measurement)	....	....	....	....

3. What is your final score of physical measurements?

Exercise II. Getting Your Physical Standards

1. Taylor's tables of standards. The following table of standards, for people of five different types of build, were prepared by Charles K. Taylor, of the Department of Standards of Carteret Academy, for the Century Company's book, *The Boy's Camp Manual.* The

tables are here given only in part. The full tables may be obtained of Professor Taylor at the Carteret Academy, Orange, N. J., by the purchase of his little book, *Physical Standards for Boys and Girls.*

A. Table for Males of Slender Build

Height	Weight	Shoulder Girth	Chest Girth	Chest Expansion	Right Arm Relaxed	Difference	Left Arm Relaxed	Difference	Waist	Hips	Thighs	Calves
51	54	28½	22½	2¾	6¼	⅞	6	¾	19½	23¼	14	9½
52	56	28¾	23	2¾	6½	⅞	6¼	¾	19¾	23¾	14½	9¾
53	58	29⅜	23¼	2¾	6⅝	1	6⅜	¾	20	24	15	10

B. Table for Males of Slender-Medium Build

Height	Weight	Shoulder Girth	Chest Girth	Chest Expansion	Right Arm Relaxed	Difference	Left Arm Relaxed	Difference	Waist	Hips	Thighs	Calves
51	56	29½	23½	2¾	6⅜	⅞	6¼	¾	20	25	14⅞	10⅛
52	59	29¾	23½	2⅞	6⅝	1	6¼	¾	20⅜	25⅜	15¼	10⅜
53	61	30¼	24⅜	2⅞	6¾	1⅛	6½	⅞	20⅞	26	15⅝	10½

C. Table for Males of Medium Build

Height	Weight	Shoulder Girth	Chest Girth	Chest Expansion	Right Arm Relaxed	Difference	Left Arm Relaxed	Difference	Waist	Hips	Thighs	Calves
56	75	34¼	26⅜	3¼	7¾	1¼	7½	1⅛	23⅜	28	17¼	11½
57	78	34⅜	26¾	3⅜	7⅞	1¼	7⅝	1⅛	23¾	28½	17⅝	11⅝
58	83	35⅜	27⅜	3⅜	8	1¼	7¾	1⅛	24⅛	29	18	11¾

D. Table for Males of Medium-Heavy Build

Height	Weight	Shoulder Girth	Chest Girth	Chest Expansion	Right Arm Relaxed	Difference	Left Arm Relaxed	Difference	Waist	Hips	Thighs	Calves
51	62	31¼	25⅛	2⅞	7⅛	1	6⅞	⅞	21½	26	16⅛	11
52	66	31⅝	25½	3	7¼	1⅛	7⅛	1	22	26¾	16⅜	11⅜
53	68	32	26	3	7⅜	1⅛	7¼	1	22¾	27	16¾	11⅝

E. Table for Males of Heavy Build

Height	Weight	Shoulder Girth	Chest Girth	Chest Expansion	Right Arm Relaxed	Difference	Left Arm Relaxed	Difference	Waist	Hips	Thighs	Calves
51	65	32	26	3	7½	1⅛	7¼	1	22½	27	16½	11¼
52	69	32⅝	26¾	3	7½	1⅛	7⅜	1	23⅛	28	16¾	11¾
53	74	33	27⅛	3⅛	7⅝	1¼	7½	1⅛	23¾	28⅝	17⅛	12⅛

2. **How to use the tables.** Locate in one of the five tables above, the height-weight line that is nearest to your own height and weight. The table in which that line occurs will give you your type of build. If you are in doubt as to which table is nearest for your records, try the nearest line in each of two tables, and the one that gives you the highest total credit is the one to go by. From this table figure out your own record of standards, so far as the table gives these standards. Enter these standards in a table in your notebook corresponding to the table on page 4 in this book. What is your type of build?

3. **Marking your scores.** Mr. Taylor recommends the following method of scoring, taking 100 as the ideal score that any one should have:

A. In your measurements for the girth of the shoulders, the expanded chest, each arm, the waist, and the average of the calves, find how many *quarters* of an inch your measurements are different from the standard for each of your seven measurements. Put this number for each measurement in the column of *plus* credits, if your measurement is above the standard; put it in the column of *minus* credits, if it is below the standard.

B. In the differences in the two measurements of your arms and chest (chest expansion), find how many *eighths* of an inch each of your measurements is different from the corresponding standard. Put this number for each measurement in the column of plus credits, if your measurement is above the standard; put it in the column of minus credits, if it is below the standard.

C. In the cases of hip and average thigh measurements, allow one score point to be placed in the plus or minus credit column, as the case may be, for each *half* inch your measurements differ from the standard.

4. **Getting your final score.** Add up the scores in the column of plus credits, and those in the column of minus credits, and find the difference between these two sums. If there are more plus credits than minus credits, add the difference in the sums to 100. If there are more of the minus credits subtract the difference in the sums from 100. The result in either case will give your final score. What is it?

5. **Correcting your defects.** Study carefully all the measurements in which you have a minus score, and in your notebook make a record of what you are going to do by way of practice to bring your scores all up to the standard for you.

EXERCISE III. MAKING A NOTEBOOK

Reference has been made in the foregoing exercises to your notebook. A notebook is an important part of this course.

1. **The kind of notebook to have.** The paper for your notebook should be about 7½ inches by 10 inches in size. However, your teacher can advise you about that. It is best to have loose sheets so they can be put into your notebook as you need them.

2. **What to write in your notebook.** In this textbook you will find that for each paragraph that is numbered, there are one or more questions to be answered or there is something to be done. For each of the Studies you should copy in your notebook the title of the Study and then the titles of the Exercises. For each Exercise you should write down the number and title of each paragraph, following the paragraph title with the question or questions found at the end of each paragraph. Then, after the questions you have copied, write the answers you have found for the questions.

3. **Following up a Study.** At the end of each Study there is usually a list of Questions for Investigation. After you have written the answer to the last of these questions, you should write down any information you have gathered on the Study and that you have not already written about.

4. **How to finish a Study.** It will be most interesting to finish each Study with scrapbook pictures and original drawings. You may cut out of magazine advertisements pictures that will illustrate health activities and instruments, or you may make appropriate pictures of your own. In either case, be sure to write a good title under the picture. Perhaps your teacher will furnish you with

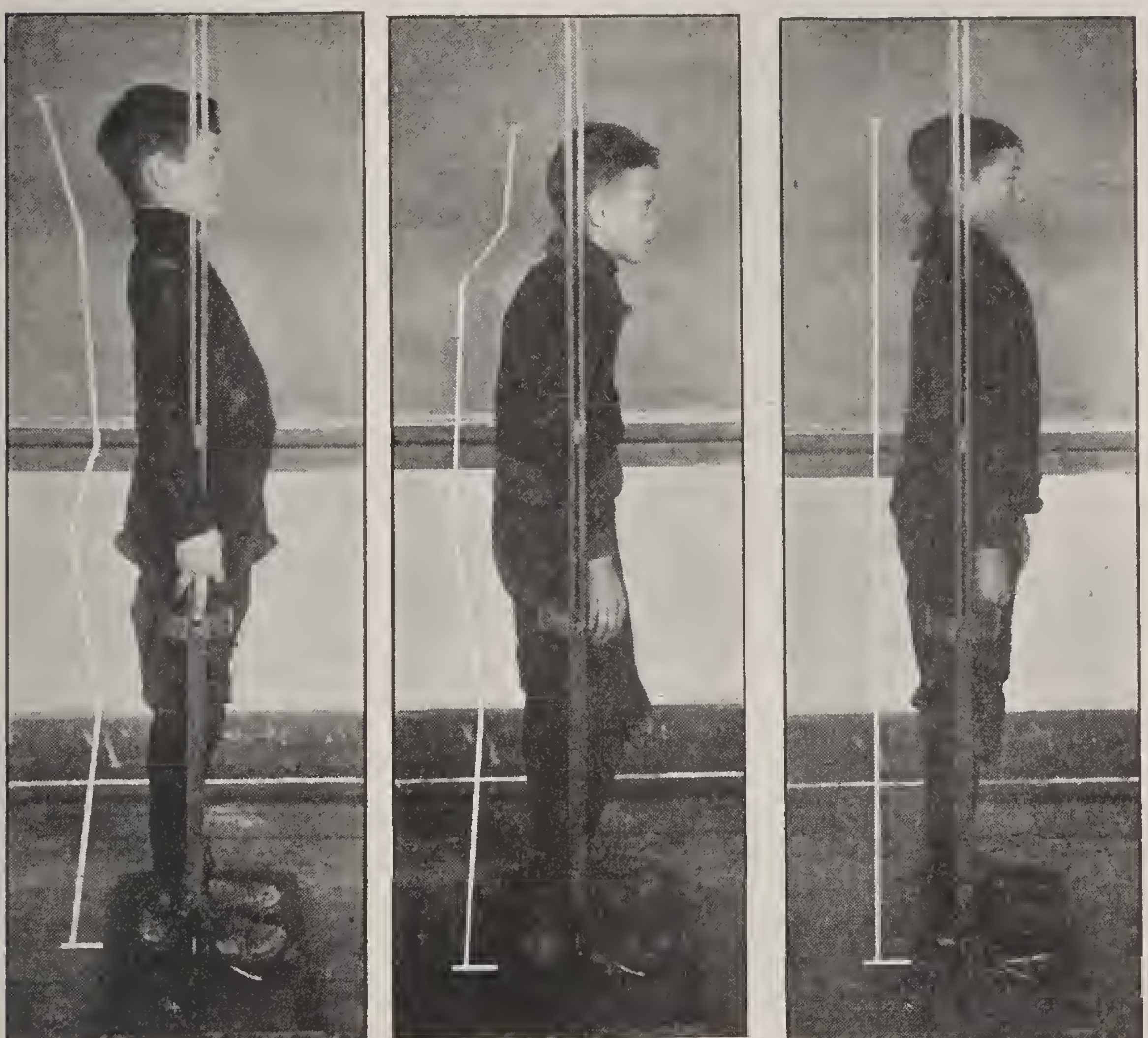
some hectographed sketches or tables that you may use. The more original you can make this part of your book, the better it will be.

5. **What to put in the back of your notebook.** Among the last of the questions asked in each Study there is usually one calling for the list of health habits you should form. In an appendix at the back of your notebook, you should keep a list of all the health rules that you and the rest of the class and the teacher agree are the best ones to follow. This list will grow as you continue your study of hygiene. Try very hard to practice all these rules of health until they become habitual with you. The organization of a Health Club will help you to do this. In Appendix A of this book you will find a plan for such an organization.

STUDY TWO

MAKING THE BODY STRONG AND STRAIGHT

YOU have surely heard the remark, "He walks like a soldier," and perhaps you have seen some man who served long as a soldier, walking as straight as if he were still in the ranks. You can recognize a well-drilled soldier almost as quickly by his excellent body posture as by his uniform. Fortunately for you, unless you have suffered some injury, you can walk as straight as any soldier, if you try



FIGS. 3, 4, AND 5. Three types of posture. The lines show the three "posture angles." Which type of posture do you have, and which type would you like to have?

hard enough. But to do so will take some effort, and it is important that you start practicing a better posture at once.

Exercise I. The Work of Muscles

1. **Getting ready to study a muscle.** Take a piece of rubber band about 2 inches long and ¼ of an inch wide, and stretch it to twice its first length. How does a rubber band change in thickness and width when it is stretched?

2. **How muscles hold bones in place.** Take two such rubber bands, each about 2 inches long and ¼ of an inch

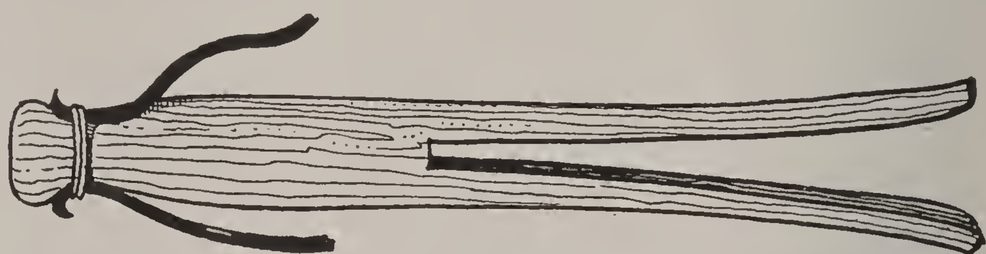


Fig. 6. A clothespin with elastic bands attached, ready for mounting.

wide, and tie them firmly in place above the head of a clothespin, as shown in Figure 6. At the top of a section of broomstick, hollow out a pit into which the round head of a clothespin will fit. With rubber bands and thumb tacks, fasten the clothespin to the piece of broomstick, at front and back, as shown in Figure 7. By shifting the position of one or the other of the thumb tacks, the clothespin can now be made to point in different directions.

3. **How a man stands up.** If you want to make a more complete showing of the way muscles work in the human body, take a piece of soft wood 1 inch thick, 2 inches wide, and 5 inches long, and cut suitable pits in the ends. Now, fasten clothespins for arms and legs and

a knob of wood for the head, and thus make a wooden man such as is shown in Figure 8.

FIG. 7. The clothespin, shown in the preceding figure, successfully mounted on a piece of broom handle. A softer piece of wood than that found in the ordinary broom handle will be easier to work, and it will hold thumb tacks better.

4. **Locating the finger muscles.** Straighten out your index finger and then make it point in various directions. While the back of your head is kept motionless, feel your forearm and find where the muscle lies that makes the finger bend forward.

A. Where is the muscle that bends your finger, and to what are its ends fastened?

B. Where is the muscle that straightens your index finger, and to what are its ends fastened?

5. **Locating other muscles.** Where do your muscles lie that do the following things: bend your elbow? raise

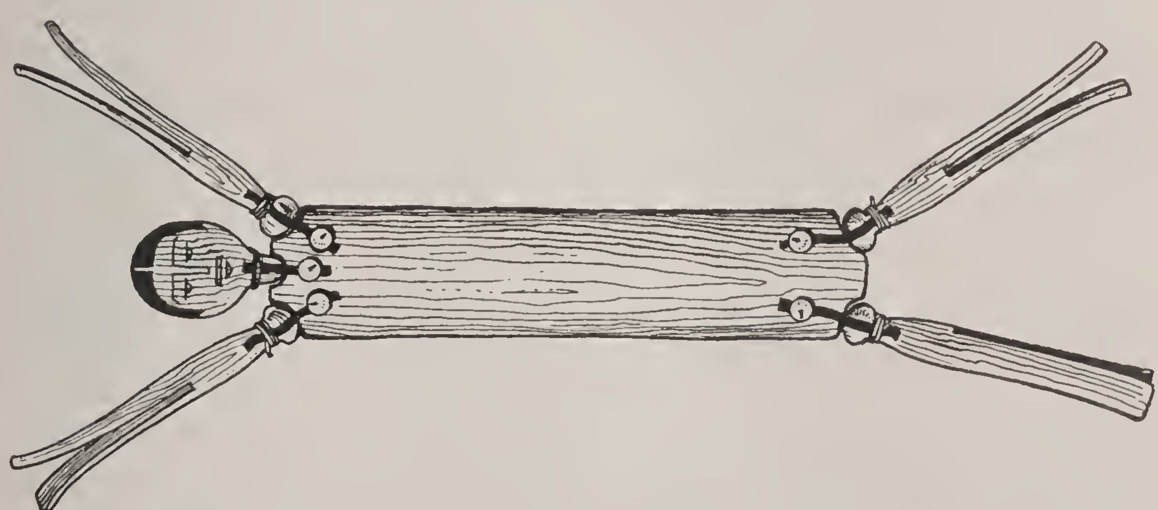


FIG. 8. A wooden man. His arms and legs can be set in various positions by shifting the thumb tacks that attach the rubber bands to the body.

your arm at the shoulder? bend your head forward? raise your thigh while you are sitting? bend your leg at the knee? straighten your foot at the ankle? bend your toes downward?

6. **Finding out about the arm muscles.** By trying out on a pole, or a tree limb, find how many times you can chin yourself. What pupil in your class can chin himself the most times? Who cannot chin himself at all or perhaps only once? Which pupil in the class has the biggest arm in proportion to his body?

Exercise II. Keeping a Good Posture

1. **Improving your posture.** Show on your wooden man what muscles must be stretched to make a person naturally stand straight, with head erect.

A. Which, if any, of your own neck muscles need strengthening?

B. What can you do to give yourself the best head and neck posture?

2. **Spoiling good posture.** What are some of the things that you sometimes do in school, on the playground, and around home that tend to give you a bad carriage of the body?

3. **Taking your posture angles.** The ideal standing posture is a nearly straight line for the head and neck, upper and lower trunk, thighs, and legs. Stand in your usual manner near a straight stick rising straight up from the floor. Let the teacher or some member of the class note how much, if any, each portion of your body bends away from a straight line. Draw a line to represent your posture as in Figures 3, 4, and 5. Make a copy of this line in your notebook and label it, "My Posture Angles."

4. **An exercise to improve posture.** The posture defect

that you are most liable to have consists in carrying the head bent forward too much. A good exercise to help correct this is called "bridging." It is performed as follows: At home, preferably just after rising from bed, lie down on your back, loosely fold your arms on your chest, and arch the body as much as possible by supporting it on the heels and the back of the head. You will have to bend your knees slightly, but not very much. Arch the body as fully as possible and allow it to drop back at once. How many times in succession can you do this exercise of bridging before you have to stop to rest, and how many times can you do it after practicing every morning for a week?

5. Your footprints. Soak a piece of cheesecloth or other cloth with a half-and-half mixture of water and strong glycerine solution of chlorid of iron. When you have taken your shoes and stockings off at night, lay on the floor or on a smooth board a sheet of unglazed paper large enough for you to make two footprints on it. Rub the sole of one foot all over with the saturated cloth, in order to get a thin coat of the solution spread over the

FIG. 9. The print at the right is that of a properly shaped foot, while the print at the left is that of a foot with badly broken arches. The inner prints show two grades of imperfection due to different degrees of breakage. Which of these footprints do the prints of your own feet most resemble?

bottom of your foot. Place the foot on the sheet of unglazed paper, throwing the full weight of the body on the foot, without any wabbling, and then remove the foot. Similarly, take an impression of the sole of the other foot. Wash both feet without further delay. Write your name on the back of the paper and lay it away to dry. At some later class time, the teacher will probably make a display of all the footprints brought in by members of the class, not giving the names of the owners. The footprints may then be examined and compared with the prints shown in Figure 9.

If it is desired to make the footprints black, press the paper back down on a piece of cheesecloth moistened with a water solution of tannic acid. The moistening of the glycerine and the iron chlorid with tannic acid makes a real ink. Paste your footprints in your notebook. What kind of footprints do you have — good, fair, or poor?

6. A good sleeping position. If you are stooped, you can improve the way you carry your shoulders, or you can help to keep your shoulders more nearly square and erect, by the way you lie while asleep. A good posture to take for sleeping is to lie on one side of the body and keep the under arm *behind* the trunk instead of *in front of* it. What is your sleeping posture?

Exercise III. Questions on the Foregoing Exercises

1. How do you think a muscle gets shorter when it contracts?
2. How do you manage to walk?
3. Where are the muscles that are most used when you are running?
4. Why is it worth while to be strong?

5. In what two different ways can you fix your wooden man so that he holds his head bent forward?

6. What are two different reasons, therefore, why some people may carry their heads with the neck bent forward?

7. What are you going to do to retain or to develop a good carriage of your body?

8. What are you going to refrain from doing so as not to spoil the carriage of your body?

9. Does each of your footprints show two good arches, one crosswise back of your toes and the other between this arch and your heel?

10. Why should you try to correct flat-footedness?

11. If your toes are crowded together too much, how can you correct the defect?

Exercise IV. Questions for Investigation

1. What is the skeleton?

2. What is a muscle?

3. How can you keep a good posture while standing or walking?

4. How can you keep a good posture while sitting?

5. How may a poor posture be harmful to health?

6. Why is it particularly important to keep a good posture throughout childhood and youth?

7. Why should exercise not be neglected?

8. How can flat-footedness be corrected?

9. Give three rules by which to be governed in taking exercise.

STUDY THREE

GOOD AIR AND HOW TO BREATHE IT

One manufacturer builds automobiles to run 10,000 miles before they should need much fixing. Not all his machines run that far, but the fault is not his. Some drivers are careless with the machines, and they wear them out long before they have run the 10,000 miles that they should.

Most animals live five times as long as it takes them to grow up, and a human being grows up in about twenty years. How long, then, should a man or a woman live? Why do so few people live that long? You are to study your own body, the most wonderful of machines, so that you may know how to make it last as long as it should. Your first step in this study will be to examine your breathing.

Exercise I. Making a Lung Tester

You will need a spi-rom′-e-ter, or lung tester, to measure the volume of your breath. One of these can be bought; but it is cheaper and much more interesting to make one (Fig. 10). For a home-made spirometer you need a big bottle — one that will hold a gallon, or about that much. Set your bottle on a level table. Take a cylinder-shaped water glass and find out how high up 10 cubic inches of water will fill the glass. Then make a scratch or an ink stroke on the outside of the glass at the level that marks just 10 cubic inches.

Now begin to fill your gallon bottle, putting into it 10 cubic inches of water. Using a sharp file, cut a mark on the outside of the bottle at the level of the water now in it. Put 10 more cubic inches of water into the bottle and

FIG. 10. Testing the lungs with homemade apparatus. Note the marks on the big bottle and the way in which the bottle is held.

scratch another mark at the new level. Keep this up until the bottle is full and you have completed marking the side of the bottle. Of course, one such bottle will do for the whole class.

For your study you will also need a dish pan or some other big vessel, a rubber tube having an inside diameter of about ½ inch and about 2 feet long, and a glass tube about 3 inches long stuck into one end of the rubber tube for a mouthpiece. There should also be at hand a bottle of strong denatured alcohol with a poison label on it, a small pitcher of water, and a waste bucket.

1. What kind of lung tester have you decided to use?
2. Make a drawing of your lung tester.

Exercise II. Testing Your Lungs and Studying Breathing

1. **Getting ready to test.** Pour water into your lung tester until it is clear full. Also fill your dish pan, or other vessel, about three fourths full of water. Put your hand tightly over the mouth of your bottle and turn it upside down, putting its mouth under the water in the other vessel. Now put one end of the rubber tube into the mouth of the bottle. Some one must hold the big bottle so its mouth will be near the bottom of the water in the vessel, and he must keep the end of the tube in place.

2. **Taking the test.** Before testing the lungs, you must destroy the germs on the glass mouthpiece of the rubber tube by pouring a few drops of denatured alcohol on it and then rinsing it thoroughly with water. You must then, while sitting crowded down in a seat, take in the biggest breath possible without straightening up. Place the mouthpiece of the rubber tube in your mouth and exhale into the big bottle all the breath you can without taking more breath into your lungs. The person holding the bottle must see that the level of the water in the bottle is even with the surface of the water in the vessel at the moment when you get through blowing. Then he must hold the bottle exactly at this level until he has counted the number of cubic inches that show your breathing capacity.

Now pour some clean water on the mouthpiece of the rubber tube, some drops of denatured alcohol, and then some more water, leaving the tube ready for the next pupil to use. The records of all members of the class should be placed on a blackboard, for making compari-

sons in the form of a table. What is your breathing capacity while sitting down humped over?

3. **Making the record.** Let a record now be taken of yours and the other pupils' lung capacities when standing perfectly erect. Let each pupil in turn stand erect, draw all the breath he can, rise on his toes and draw more breath if he can, and then quickly take the glass mouthpiece and exhale into the bottle all the breath he possibly can.

A. What is the breathing capacity of each pupil while standing perfectly erect?

B. In which test, sitting or standing, did you give off the larger breath and why?

Exercise III. Experiments with Breathing

1. **Saying "Ah."** See how many seconds you can continue to say "Ah," using as little breath as possible while doing so. Set down the result along with the results for the other pupils, both on the blackboard and in your notebook. How long can you continue to say "Ah" with only one breath?

2. **Breaths per minute.** By careful counting, find out how many times you take in breath naturally in a minute: first, after you have been sitting quietly; and, second, after you have been running for a half minute or so. Write your answers in the table on the blackboard and also in your notebook. How many breaths a minute do you take when you have been quiet, and how many do you take after exercise?

3. **How you breathe.** Let some one in the class provide a stopperless bottle that might have held about a quart, but with the bottom now knocked out of it. The broken end will need to be rubbed with a file to take off

its sharp edges. A piece of rubber dam, such as a dentist uses, 5 or 6 inches square, must now be tied tightly over the bottom end of the bottle.

The teacher, in the presence of the class, will illustrate how you get air into and out of your lungs. While holding the bottle before the class with one hand, she will press the rubber bottom of it upward until it goes an inch or more into the bottle. Let a pupil now hold a burning match over the mouth of the bottle while the teacher takes her hand away from the bottom and then presses the bottom upward again, the class meantime watching how the flame behaves. Why does the flame go *from* the mouth of the bottle when the bottom is pressed upward, and *into* the bottle when the pressure is withdrawn?

4. **Abdominal breathing.** Across the middle of the body there is a big, broad, sheet-like muscle called the di′a-phragm, fastened all around the lower ribs, and separating the upper part of the trunk from the lower part. The organs in the lower part of the trunk thrust the diaphragm up into the chest so that the muscle is usually placed like a bowl upside down. You need to find out how you make this muscle work. To do this you must stand and place your hands on your abdomen. Now drive all the breath you can out of your lungs. With the fingers of your hands note what is going on in the abdomen and where the muscles are that are doing the work. Now take in a good, full breath, keeping the hands where they were, and notice where the same muscles, or different ones, do the work for taking *in* breath. The kind of breathing you have just been doing is called *abdominal* breathing. In abdominal breathing, where are the muscles located that are used when breathing in; and where are those located that are used when breathing out?

5. **Chest breathing and mixed breathing.** Try to breathe again, this time placing one hand on your chest and the other on your abdomen. See if you can breathe and yet move only the ribs and not the abdomen. If you succeed, you know what is meant by chest breathing. Mixed breathing uses both the chest and the abdomen. With chest breathing you use some muscles between the ribs. Have someone measure your chest when you have forced out of your lungs all the air you can and again when you have filled them as full of air as possible. Place the tapeline around your chest a little below the armpits. Write the results in the proper place in the table of your measurements in connection with Study One.

A. Where are the muscles that are used in chest breathing?

B. What is mixed breathing, and why is it valuable?

C. What is the girth of your chest when you have filled your lungs as full as possible?

D. What is the girth of your chest when you have emptied your lungs as much as possible?

E. What is your chest expansion; that is, the difference between the two measurements just taken?

Exercise IV. Experiments with Air

For the following experiments you will need two wide-mouthed bottles, each holding about a pint. Milk bottles holding a pint are about the best kind of bottles to use. You will also need two short candles, such as are used on birthday cakes. Then you must have some clear limewater. This may be bought at a drug store, or it may be made by pouring a pint or more of rain water over a small chunk of fresh quicklime in a vessel, such as

a quart fruit jar, and letting it stand until the clear limewater can be poured off into a separate bottle.

1. **What a burning candle needs.** The air you breathe is made up of several kinds of gases, one of which is *oxygen*. Now anything that burns must have oxygen, or the flame will go out.

Fix both of the candles so they will stand up on pieces of cardboard about 3 inches square. Light one of the candles and then invert one of the bottles over it, letting the bottle stand on its mouth until something happens to the candle flame. Keep this bottle covered for later use. What happened to the candle flame that was under the bottle, and why did it happen?

2. **What a living animal needs.** Any animal is like a burning flame, in that it has to have oxygen to keep it from dying. Put a mouse under a small jelly glass. When it begins in a few minutes to pant heavily for breath, let it out, for it will die if it stays under much longer. Keep the air from the mouse's breath under the jelly glass for later use. Why would the mouse die if you kept it under the jelly glass very long?

3. **What a candle flame gives off.** At the same time that the candle flame in the first experiment was using up oxygen, it was making another gas called *carbon dioxid*. You can always tell when you have this gas, because it turns limewater milky. Take the bottle left over from the first experiment and pour into it some clear limewater; then shake the bottle so as to mix the air and the water. How do you know that air from a burning candle contains carbon dioxid?

4. **What a breathing animal gives off.** In a similar way, test the air in the jelly glass under which you kept the mouse. How do you know that the air from a breathing animal contains carbon dioxid?

5. **Carbon dioxid in ordinary air.** May it be that ordinary air, such as was put over the burning candle and over the mouse, has a lot of carbon dioxid in it? See for yourself. Take a clean bottle with fresh air in it and pour a little limewater into it. Now shake the bottle and see whether the limewater turns milky. How do you know that ordinary air has, at most, not more than an extremely small amount of carbon dioxid in it?

6. **Is there carbon dioxid in your own breath?** Blow through a glass tube into the bottle that you just used, so as to fill it with your breath, the limewater still being in it. Now shake the bottle, mixing the limewater and the air that came from your lungs. What have you learned from mixing your breath with limewater?

7. **Effect of human breath on a flame.** Clean both of these bottles and get some fresh air into them. Again fill one of them with air from your lungs. When both bottles are ready, start the two short candles to burning, and then turn both bottles upside down, one over each candle. Under which bottle, the one with fresh air or the one with breathed air, does a candle flame go out the quicker, and why?

8. **Is there any odor to your breath?** You may now fill a bottle or a glass fruit jar with your own breath and let it stand, carefully covered, until some time when you come in fresh from outdoors. Then smell the contents of your bottle or jar. If there is a bad odor, it is probably due to decayed teeth or diseased tonsils or nostrils. Does a bottle standing a while with your own breath in it smell bad, and if so, why?

Exercise V. Questions on the Foregoing Exercises

1. Of two boys of the same size but of different lung

capacities, which one do you think could run the farther without getting out of breath, if their hearts are equally strong?

2. Why should you sit erect in your seat?

3. What do you notice about the chests of the finest-looking persons you meet?

4. How do you suppose you can develop a larger chest and lungs?

5. Will you and the other pupils test your lungs once a month to see who in your class can make the biggest improvement; that is, who can gain the most cubic inches of breathing capacity?

6. How do you get air into your lungs?

7. How do you get air out of your lungs?

8. Which kind of breathing — chest, abdominal, or mixed — do you think is best for you, and why?

9. How do you know the air you breathe out is different from that you breath in?

10. If your breath smells bad, what should you do about it?

Exercise VI. Questions for Investigation

1. Why does the body need air?
2. What breathing is best?
3. What air is good air?
4. How can you get fresh air to breathe?
5. What are the lungs?
6. What two distinct things do the lungs do for the blood?
7. How can you keep your lungs in good condition?
8. What good breathing habits should you have?

STUDY FOUR

LEARNING ABOUT YOUR BREATHING ORGANS

I WONDER if you can tell seven different uses of the nose without having to think long; but you need not try to do this just now. The fact is that the nose is a much more important organ than most people realize, to say nothing about its being such an ornament to the face! You are to have a chance in this Study to learn about the nose and the throat as well, for you are about to make some interesting experiments with air and breathing. Both nose and throat play an important part in the breathing act, and whether or not you are to have a strong body depends very much on the condition of your nose and throat.

EXERCISE I. STUDIES OF THE NOSE

1. **The outside of your nose.** With clean thumb and finger of one hand, bend the nose down and sidewise to find the answers to the following questions:

A. What keeps the nose from flattening down?

B. Is the partition between the nostrils made of gristle, like the breastbone of a spring chicken, or is it made of solid bone?

C. What part of the outer walls of the nose is made up only of flesh?

D. What part is made up of bone and flesh?

E. Is your nose wide, or narrow, in comparison with the widths of the noses of other boys and girls of about your age?

F. Noses are of various shapes, and it really doesn't matter much what shape your nose is, if only the breathing passages in it are well open. But just for the fun of it,

FIG. 11. Examining the inside of the nose. Notice how the girl holds the mirror in relation to the source of light.

you may answer in your notebook this question: Is your nose Roman, Grecian, snub, or some other kind?

2. **The inside of your nose.** For the second study of the nose you need to sit with your face turned away from any strong light (Fig. 11). Hold a mirror in front of your face so that the mirror will reflect plenty of light up into your nostrils and so that you can see the reflection of your inner nostrils in the mirror. Use the fingers of your free hand to press or pull the end of your nose in ways that will let you see well into one nostril at a time. Find and write down the answers to the following questions:

A. Does the partition between the nostrils divide the nose into two equal spaces, or is it placed nearer to one side than the other?

B. In what part of the nostrils do you find the long hairs?

C. Which wall of a nostril, inner or outer, is the more regular and smooth?

D. Where do you find what seem like red pads?

E. What direction do the nostrils seem to take at their upper ends?

Exercise II. Uses of the Nose

1. **Smelling.** Place any agreeable-smelling stuff under the nose and breathe in the odor by one strong but steady breath. Now breathe in again, but this time bring the air in by jerks; that is, sniff the odor from the substance. In which way can you smell the better, by sniffing or by taking a steady breath, and why is this so?

2. **Talking.** Press with the finger against one side of the nose so as to shut off the air from one nostril, and then talk out loud. Do this again, but close the other nostril instead of the first one. Now close both nostrils and talk out loud. In "talking through your nose," as you say, do you really use your nose?

3. **Moistening the breath.** Close the nostrils, and then through the wide-open mouth breathe in some very dry air from over a warm stove, register, radiator, electric heater, or burning lamp, taking in a long breath. Now close the mouth and breathe in a long breath of the warm, dry air through the nostrils.

A. Which seems to dry out the quicker, the mouth or the nose, on taking in a breath of very warm, dry air?

B. What becomes of the moisture that is lost from the mouth or nose?

C. How is this a protection to the lungs?

D. Why do you think the nose dries out less readily than the mouth on breathing dry air?

4. **Warming the breath.** If possible, breathe in some very cold air, first through the mouth and then through the nostrils, in each case taking a long breath.

A. Which is less disagreeable to do, to inhale cold air through the nostrils, or through the mouth?

B. Where does the heat come from that serves to make the air warmer and more agreeable in the one case than in the other?

5. **Protecting the lungs.** When you looked up into your nostrils you found some hairs at the lower part. You also saw that the nostrils deeper in are moist.

A. What effect do hairs and moisture in the nose have on inhaled air that is full of dust?

B. You sometimes see ill-mannered people "picking their noses." Where does the stuff first come from that they get out of their nostrils?

6. **Destroying germs.** The moisture that is found on the deeper parts of the nostrils contains some substance that tends to kill germs. Why is it important to keep the inner surface of your nose in a healthy condition?

7. **Giving facial expression.** Keep the nose pinched shut for about 5 minutes, just to see how it would be if one could not breathe through the nose. If you had to go with your nose pinched shut all the time, how would this affect the shape of your mouth and face?

8. **Uses of the nose.** What are seven distinct uses of the nose, as shown in the seven studies you have just made?

Exercise III. Taking Care of the Nose

1. **Using a handkerchief.**

A. To clean the nasal surfaces, put a part of the handkerchief over the index finger and then gently rub

the surface clean. Why should you not ordinarily put a bare finger-end into a nostril?

B. To blow the nose, place part of a handkerchief loosely over both nostrils and hold it in position by pressing it lightly against the lower side of one nostril to prevent the escape of air through it. Now force a lot of air through the partly open nostril, without making a loud noise. Treat the other nostril in the same way. Have you become skillful in blowing your nose properly?

C. Why should you not blow your nose without using a handkerchief?

2. **Washing your nose inside.** Some time you will need to wash out your nostrils. This is how to do it: Take a cupful of warm water and mix into it a teaspoonful of common salt (the cup should be one that will not be used for another purpose). Close the mouth and hold one edge of the cup against the upper lip and the lower edge of the nose. Close one nostril with a finger, duck the nose into the water, and very gently draw the salt water up into the open nostril. Now force the water out again, away from the cup. Repeat several times for each nostril. What trouble, if any, did you have in washing out your nose inside?

Exercise IV. Studies of the Throat

1. **The throat, or pharynx.** This organ lies back of the mouth cavity and may be examined by using a mirror as was done in studying the nose. In the back part of the mouth you will see a nipplelike body, called the *uvula*, hanging down into the entryway to the *pharynx*, which is the hollow body back of the mouth and uvula.

A. By trying, see how much you can change the length of the uvula. How much can you change it?

B. There are two stretched bands of flesh running up from the outer, back parts of the tongue to the roots of the uvula. Are they in *front* of, or *behind*, the pharynx?

2. The tonsils. Unless you have had your tonsils cut out, you should find two of them, looking naturally like two red, unripe mulberries, about the size of the end of a little finger, one on each side of the lower, back wall of the pharynx.

A. Have your tonsils been cut out? If not, are they of natural size; that is, as big as a ripe mulberry or the last joint of your little finger?

B. White patches on the tonsils show that there are many germs in the tonsils and that they are therefore diseased. Are your tonsils very, very red and do they show white patches?

3. The hard and the soft palate. Thoroughly clean your fingers, and with one of them feel the roof of your mouth, called the *palate*. The front part has bone above it and is called the *hard palate*. The back part is called the *soft palate* and ends finally in the uvula. If the soft palate cannot be pressed up very much, it may be because you have *adenoids* in the back part of your nostrils and the upper part of your pharynx, into which the nostrils lead. If so, the adenoids should be taken out by a physician, for if retained they interfere with all of the seven uses of the nose. The operation is a slight one and should not be expensive. Do you now have adenoids above your soft palate?

4. The Eustachian tubes or throat-ear tubes. Sometimes when you go up on a high building or come down from one, you have a sort of ringing in the ear. You may also get this ringing in the ear from other causes. When you have it, you may usually get rid of it by simply

swallowing. This is because the swallowing act opens up a tube leading from the pharynx to the middle ear, which then lets air into or out of the middle ear, as may be needed, — out of it when you go up, and into it when you go down. If this *Eustachian tube* or *throat-ear tube* has grown full of adenoid substance, swallowing will not stop the ringing. You should then have this throat-ear tube looked after by a physician, for the condition may lead to deafness. What causes a ringing in your ears, if you have it?

5. **The epiglottis.** So far, we have found five openings into or from the pharynx. Another one is at its lower end, and through it the food passes into the gullet on its way to the stomach. But there is still another opening near the lower end, through which the air passes on its way from the nose and pharynx to the voice box, or *larynx*, on the way to the lungs. Indeed, if you try hard enough you can see the lid to this voice box. This lid goes shut when you swallow food. Take the handle of a tablespoon and press down the rear of your tongue, so that you may see the tip of this voice-box lid, or *epiglottis*, as it is called. How much of your epiglottis did you succeed in seeing?

Exercise V. Voice Box, Windpipe, and Lungs

For these studies there will be needed the lungs, windpipe, and voice box of some quadruped, carefully taken out and put in good condition for examination.

1. **The voice box.** This part of the general air passage may best be studied if it is cut free from the windpipe and then split the long way on the side that is opposite the place where the lid, or epiglottis, is fastened. Notice that there are no vocal cords that look like "fiddle strings"

across the voice box, but that there is a fold or ridge about halfway down on each side. In life these are stretched so they make two sharp edges with a very narrow slot between them. How do you think the animal made a noise with this voice box?

2. **The windpipe.** Notice that the windpipe is made up of incomplete rings of gristle, while the voice box is made of plates of gristle. Why should the windpipe be made of so much gristle instead of muscle?

3. **The lungs.** Get a glass tube several inches long and of such a diameter that the tube will just go into the windpipe with a little crowding. Insert the tube a little way into the windpipe, thoroughly clean the free end of the tube, and through it blow a full breath into the animal's lungs. Float the lungs on a dishpan of water, both when they are blown up and when they are not. In which case do the lungs sink deeper into the water, and what keeps them from sinking entirely under the water?

Exercise VI. Questions on the Foregoing Exercises

1. What makes the walls of your upper nostrils so red?

2. Because you can bleed so much from the nose, what does this show about the supply of blood that goes to your nostrils?

3. How do you think the noise is made when some one snores?

4. Why should you try to keep with you a reasonably clean handkerchief?

5. What are the seven different openings from your pharynx?

6. What keeps the food that you swallow from going into the windpipe?

7. What makes you choke sometimes?

8. Why is not the windpipe made of a *tube* of gristle instead of *rings?*

9. Why are the lungs often called "lights" by butchers?

10. Why is it that the lungs of children are pink, of middle-aged people slate-colored, and of old people living in smoky cities, almost black?

Exercise VII. Questions for Investigation

1. Why should you breathe through the nose instead of the mouth?

2. How can you keep your nose in good condition?

3. How can you keep your throat in the best condition?

4. What do you suppose happens to the voice box when people get hoarse?

5. What should be done when you get something in your windpipe?

6. How can you keep your lungs from getting slate-colored or black?

7. Why do you have ribs?

8. How can you exercise your lungs?

STUDY FIVE

THE TEETH AND THEIR CARE

You have been learning about breathing and the air you need. Soon you will take up the study of foods and how to become strong and healthy by means of them. But before you study foods you should learn some important facts about the teeth that stand ready to take hold of the food when it comes into the mouth. You will be able to save yourself money and not a little suffering in time to come, if only you make good use of the instruction to be found in this Study.

Exercise I. Studying the Teeth

1. **Temporary and permanent teeth.** The teeth that come in before a child is four years of age are called the *temporary* or *baby* teeth. Between the ages of seven and twelve, these baby teeth are all exchanged for what are called *permanent* or *second* teeth. But there are twelve permanent teeth that come in only once. At about the age of six, the first of these permanent teeth come in. There are four of them, one on each side of each jaw, just behind the hindmost of the baby teeth. A good many people do not seem to realize that the big teeth that come in at six years are permanent teeth, and never will be replaced naturally. At about the age of twelve, four more permanent teeth come in, one just behind each of these mentioned above. At eighteen years of age or later, the four wisdom teeth come in. One of these is at the very rear of all other teeth on each side of each jaw.

By questioning other persons, or by reading Ferguson's *A Child's Book of the Teeth*, find out and record how many temporary teeth anyone may have at the age of

FIG. 12. The boys here have added hydrochloric acid to water containing a human tooth, and they are watching the bubbles of gas rise as the acid slowly eats the tooth.

four or five years, and how many temporary and permanent teeth he may have at six, seven, eight, nine, ten, eleven, and twelve years.

2. **Kinds of teeth.** By the use of a mirror in the way described in the study of your nose (see Figure 11), find out the groups of different-shaped teeth you have, and if possible, the special use of each group. Make a table recording the shape and the special use of each of the following groups of teeth:

A. The four front teeth, above and below.

B. The single teeth on each side of the group of four front ones.

C. The next two teeth behind the single teeth.

D. The rearmost single teeth or pairs of teeth (three pairs in each jaw in adults).

3. **Names of the teeth.** At recitation time your teacher will give you the names that dentists use in describing the teeth. After looking the words up in a big

dictionary, she will also tell you why each group has been given its particular name.

A. Fill out the chart below; on one side write the names that the teacher gives you, and on the other side set down the ages at which each pair of permanent teeth usually come in.

B. What teeth do you use in taking bites of bread?

C. What teeth do you use in tearing meat from bones?

D. What teeth do you use in breaking a stick of candy?

E. What teeth do you use in grinding food?

4. **The parts of a tooth.** Perhaps you or your teacher will be able to borrow from a dentist some human teeth for study. With a tooth before you, find out and record answers to the following questions about the parts of a tooth:

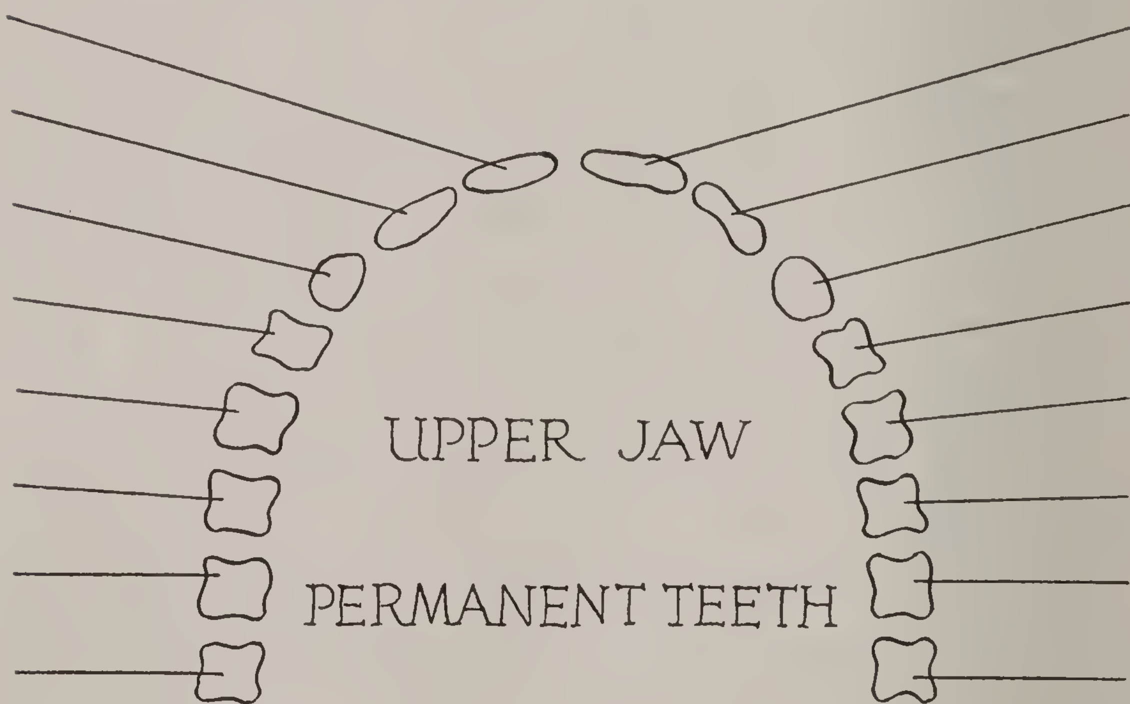


FIG. 13. A diagram of the teeth of the upper jaw. Copy this diagram in your notebook. Then at one side write the name of each pair of teeth, and at the other side write the ages at which each pair appears.

A. What is the *crown* of a tooth?
B. What is the *neck* of a tooth?

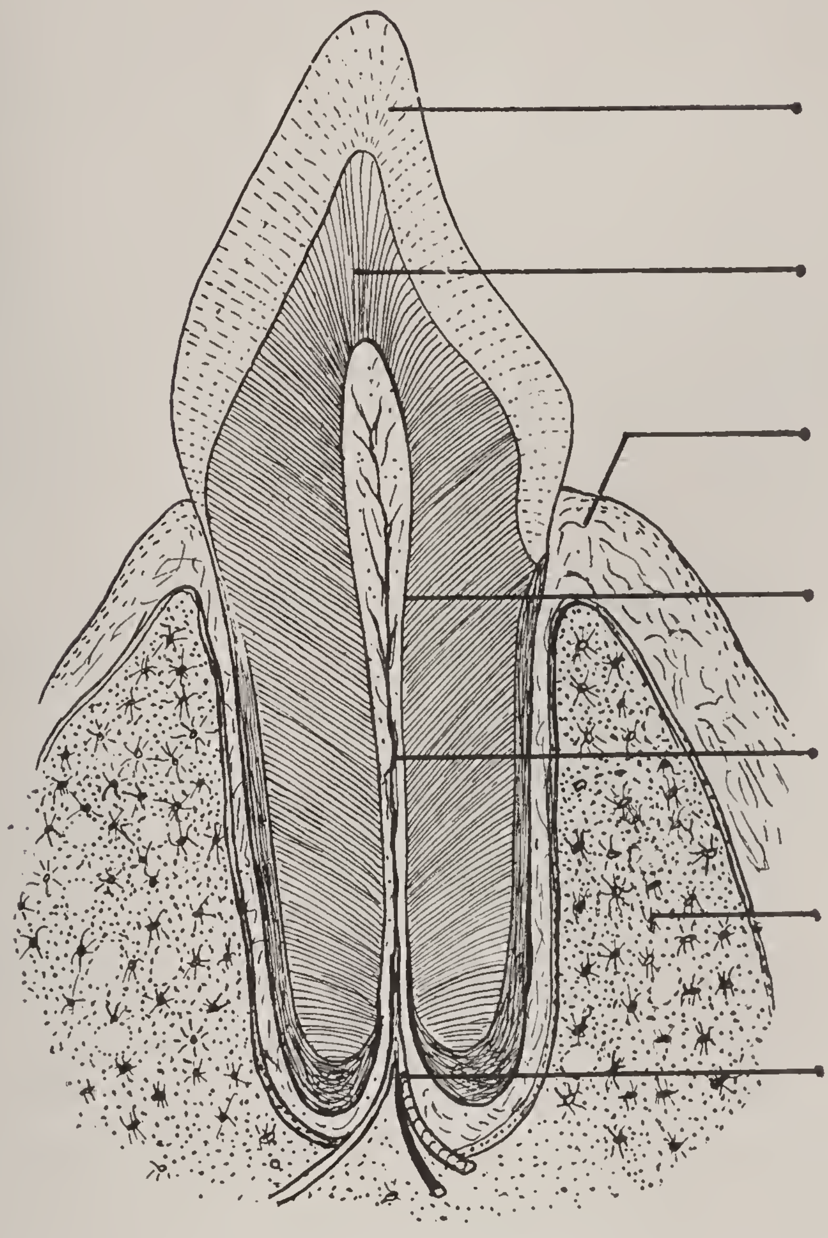


FIG. 14. A diagram of the structural parts of a tooth. Make a copy of this diagram in your notebook and label each structure with the name the teacher gives you or that you find out for yourself.

C. What is the *root* or *fang* of a tooth?
D. What teeth have only one root?
E. What teeth have two roots?

F. What teeth have three roots?

5. **The structure of a tooth.** If some member of the class will grind a human canine tooth on an emery wheel, holding the tooth sidewise and grinding halfway through it, the specimen will be useful for study in connection with Figure 14. The teacher will give you the names of the structural parts. What are these parts?

6. **Decay in your own teeth.** Examine all your teeth thoroughly for decayed spots by holding a mirror so that it will throw light into your mouth, the light coming from somewhere behind your head. Which of your teeth, if any, have decayed spots? In answering, give the names a dentist would use.

Exercise II. The Care of the Teeth

1. **Testing for acids.** Your teacher will perhaps be able to provide each member of the class with a small piece of blue litmus paper. In the presence of the class, she will then put a drop of hydrochloric acid on a piece of the paper. Any acid will change the color of litmus paper as the hydrochloric acid does. Try a drop of vinegar on litmus paper; try lemon juice; try apple juice. What change in color does an acid make on litmus paper?

2. **Acid in decayed matter.** Press some blue litmus paper against a rotten spot in an uncooked piece of fruit or vegetable. What does the litmus paper now show you?

3. **Testing your teeth.** Take home with you the piece of litmus paper which your teacher will give you. In the morning, before cleaning the teeth or eating or drinking, rub half your piece of litmus paper on the surface of a tooth. Scrub the teeth thoroughly with a brush and salt water and then rub the second half of the litmus paper on the surface of a clean tooth. What have

you learned from applying litmus paper to an unclean tooth and to a clean tooth?

4. **Source of acid on teeth.** Perhaps you have already learned that decay is caused by bacteria. There are many kinds of bacteria in a human mouth, especially if it is not kept clean. At best there will always be bacteria there, and the only way to keep down their number is not to let particles of food lodge between the teeth. How did acid come to be on your unclean teeth?

5. **Effect of acid on teeth.** Place a human tooth in half a glass of water and then put in as much as one or two teaspoonfuls of hydrochloric acid. You should now see bubbles of gas coming from the tooth (Fig. 12). The bubbles show that the acid is eating the tooth. Let the tooth remain in the glass of acid water for a day.

A. After a tooth has been in acid for a day or more, how does it look and why does it look so?

B. What difference is there in the rate at which the acid has eaten the crown of the tooth (covered with *enamel*) and the root (made up of *dentine*)?

Exercse III. Questions on the Foregoing Exercises

1. What seems to be the particular use of the enamel of a tooth?
2. Why is it not wise to crack nuts with your teeth?
3. Why is it not a good habit to bite off thread with your teeth?
4. Just how does a tooth come to decay?
5. Why should you clean your teeth after every meal?
6. Why is it more important to clean your teeth just before going to bed than at any other time?
7. Do you have a toothbrush?
8. How often have you been cleaning your teeth?

9. What are two very different reasons why you should keep your teeth clean?

Exercise IV. Questions for Investigation

1. Why is it very important that you take good care of your teeth?
2. How often should you visit a dentist?
3. Why is it the better way to have a cavity in a tooth filled by a dentist before the cavity gets large?
4. How much stronger is a natural tooth than a false one?
5. Why is it just as important to take good care of the first teeth as of the second teeth?
6. What sometimes makes permanent teeth come in crooked?
7. What should be done with crowded or uneven teeth?
8. What are some diseases that may be caused by decayed teeth?
9. What is a good kind of toothbrush?
10. What different motions should you go through in brushing your teeth?
11. Why is it particularly important to brush your teeth up and down as well as crosswise?
12. What are some habits that will help you to have sound and good-looking teeth?

STUDY SIX

WHAT AND HOW TO EAT AND DRINK

No doubt you have seen some boy you know walking slowly about his home yard. He could not run or play, and was so weak that he had to sit down often to rest. This was because he had been sick, and for a good many days had not been able to eat. Now he was beginning to eat a little and was getting back his strength. The health and strength of all of us depend so much on our foods that it will be quite worth while to make some study of what and how we eat and drink.

Exercise I. Examining Your Mouth

With a strong light coming from behind your head, hold a mirror in front of your wide-open mouth so as to throw a lot of light into it. Now examine the mouth to find each of the parts shown in Figure 15. At the right of the chart set down the names of the parts, as your teacher may give them to you, or as you may find them in some other book.

Exercise II. Some Uses of the Mouth

1. **Breathing.** Run hard until you feel that you simply cannot get enough air by breathing through your nose alone. How do you manage to get enough breath into your lungs when you are running very rapidly?

2. **Speaking.** Practice giving the sounds *of the capitalized letters only* in the following syllables: A, Be, CHew, De, E, eF, Go, He, I, Jay, Kay, Low, May, Nay, iNG, O, OIl, OUt, Pea, Row, See, Tea, THe, THigh, U, Ve, We, Ye, Ze, ZHe.

A. Which letters of the alphabet represent free, open voice sounds or *vowel* sounds?

B. Which represent merely whispered or *aspirate* sounds?

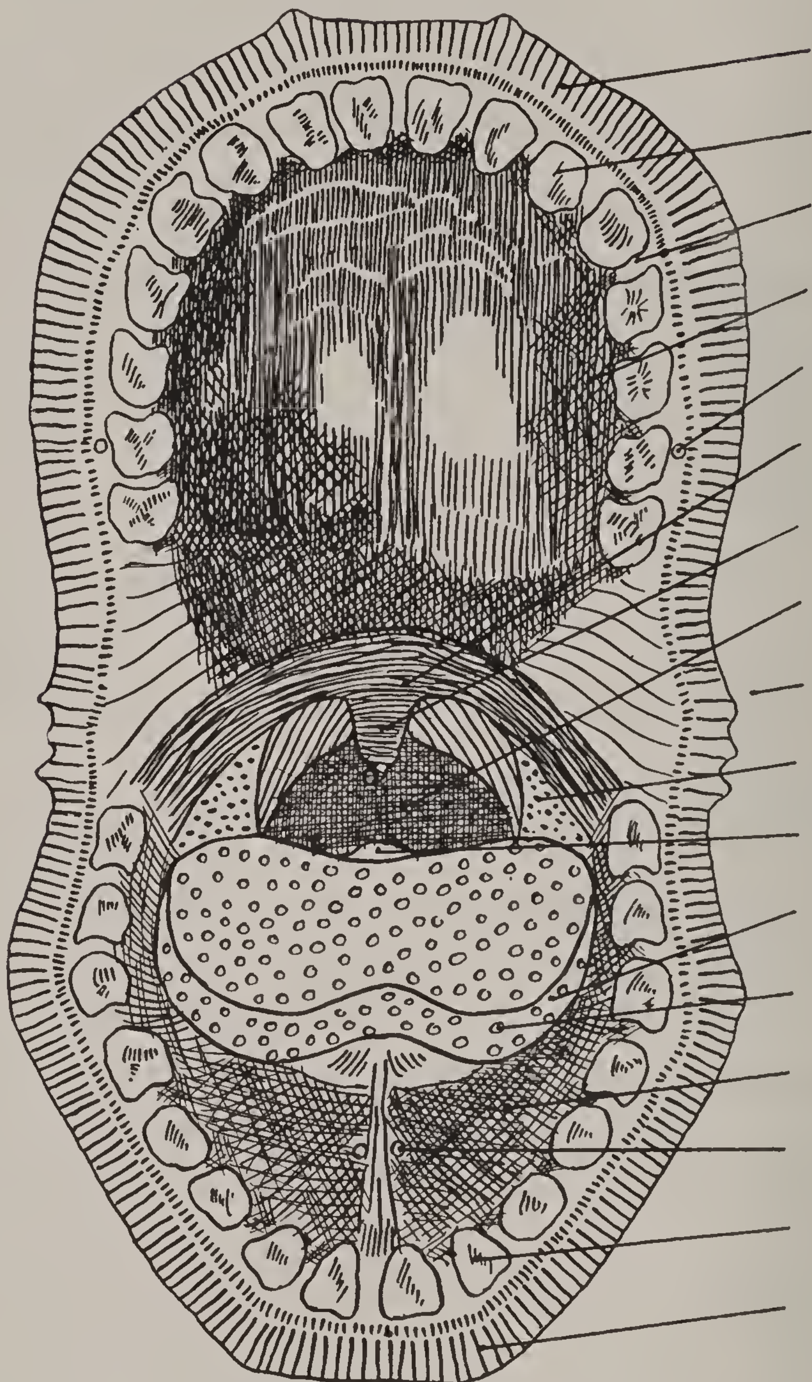


FIG. 15. This diagram indicates the different structures that can be seen in the mouth. With the aid of a mirror, examine these structures in your own mouth. Then copy the diagram in your notebook and write at the side of the diagram the names of the parts.

C. Which represent obstructed throat sounds or *subvocal* sounds?

3. **Swallowing.** When you have a chance, watch a chicken while it is drinking water.

A. Why does a chicken raise its bill every time it swallows water?

B. Why do you not have to raise your mouth as a chicken does, to drink water yourself?

4. **Moistening food.** Take a good big bite of cracker, crush it rapidly, and then try to swallow it at once. What have you learned about the use of the mouth in swallowing dry matter?

5. **Aiding chewing.** Eat a raw apple or turnip, or recall your eating one of them. For what purpose do you use your teeth when you eat such foods as hard fruits?

6. **Aiding digestion.** Put a teaspoonful of raw oatmeal into one glass of water, and put a teaspoonful of sugar into another glass of water. Let both glasses stand for a minute or two, stirring the contents several times. Then take two funnels, each emptying into a milk bottle or other glass vessel, put a filter paper or any thin, unglazed paper down in each funnel so you can separately strain the contents of the glasses you have just been stirring. Meantime, put a spoonful of raw oatmeal into your mouth and keep chewing it until it changes its taste slightly.

A. Which dissolves in the water, sugar or oatmeal?

B. Which of the two, do you think, might be carried through the walls of the food canal so that it could get into the blood to be taken around over the body?

C. What did the saliva in your mouth do with a part of the starch in the oatmeal, as you judge from the new taste you got when chewing the oatmeal?

D. Why is it necessary that this change be made in starchy foods?

E. What is digestion?

7. **The kinds of food saliva digests.** Take a teaspoonful of clean, boiled wheat grains and chew them until a small mass of "wheat gum" remains. The saliva, or liquid of the mouth, dissolves the starch in the wheat grains and leaves a substance called *gluten.* This gluten belongs to a class of foods known as *pro′te-in* foods. These will not digest or dissolve in the mouth, and they must go on to the stomach or small intestine to be digested. Neither will butter or fat of any kind be digested in the mouth. What is the only kind of food the saliva digests?

Exercise III. The Hygiene of Eating

1. **How to chew.** At lunch time take a sandwich containing meat, egg, salmon, or peanut butter, and cut it into two exactly equal parts. Eat half of it slowly, chewing every bit until it is like thin soup. Then eat the other half very rapidly and with little chewing. At the same meal, or a later one, eat the first half of a sandwich rapidly and the second half slowly. In which case, eating slowly or eating rapidly, do you get the greater satisfaction out of half a sandwich?

2. **Advantage of thorough chewing.** If you care to make a meal of sandwiches alone, it will be worth your while to try another experiment with them. With enough equal-sized sandwiches before you to serve as a meal, eat them as rapidly and with as little chewing as possible, taking note of how many it takes to satisfy your hunger. At a later, corresponding meal, do the same thing, only this time eat slowly and chew very thoroughly. Which meal requires the fewer sandwiches,

the one at which you chew thoroughly or the one at which you chew little?

3. **Are fried foods healthful?** Think of the time you may have eaten fried doughnuts and other fried foods, and then think of a time when you ate something else. What does your personal experience tell you about the healthfulness or unhealthfulness of eating much fried food?

4. **How to drink milk.** At some meal take a glass of milk and pour half of it into another glass. Drink one-half very rapidly, and then slowly sip the other half. At a later meal sip slowly the first half and drink rapidly the other half. Which is the way to drink milk to get the full benefit of it?

5. **How much water to drink.** Try drinking a glass of water before breakfast. Also drink plenty of water at meal times, but always when the mouth is free from other food. Do this for at least a week, drinking six or seven glasses of water a day. Do you find that drinking plenty of water makes you feel better and healthier?

6. **Effect of cheerfulness.** Think over the times you have eaten meals when something has made you cry or feel bad. Think of other times when you have been happy at mealtimes. In which case did the saliva flow the more freely, when you were happy or when you were sad?

7. **Vitamins.** If a farmer feeds his cattle on corn alone, they will not fatten well and will not keep in good health. This is why you see the tall silos beside the barns of good farmers. In these the farmer keeps green feed for winter. This silage gives to the cattle, among other things, substances called *vitamins*. These vitamins, which are found most plentifully in fruit, leafy vegetables, and

milk, are necessary to the proper growth not only of cattle but of boys and girls as well. Do you have vitamin foods as a part of your daily diet?

8. How much meat to eat. Many persons eat too much meat. When they do this, a good part of the meat is not digested but goes down to the large intestine, where it only feeds germs. These germs make poisons that sometimes affect the whole body. Is the meat you eat only about one-seventh of all the food you eat, if the food were all dried and weighed?

9. Constipation. One of the great causes of many ailments lies in the neglect of people to empty the bowels *at least* once a day. Are you very certain that you empty your bowels at least once a day, preferably in the morning?

10. Your proper weight. Turn to your table of measurements in Study One. If you find that your weight is much less or much more, than the standard for you, what can you do to make your weight what it should be?

11. Good table manners. Talk over the subject of good table manners with your teacher and with other members of your class. Now play that you are eating together or, better, have a real lunch together. You might choose up sides and then see which side, as a whole, is the better behaved at meal times, the teacher being the judge. Have you learned correct table manners?

12. A paper drinking cup. Make a drinking cup from the pattern shown on the opposite page. Use any strong, clear, glazed paper about 8 inches square. The teacher will explain, if you do not quite understand just how to do it.

EXERCISE IV. QUESTIONS ON THE FOREGOING EXERCISES

1. Which has the more parts to be seen in it, the mouth or the nose?

2. What are the six different uses of the mouth?

3. Which has the more uses, the mouth or the nose?

4. What is one way to tell starchy food from protein food or fatty food?

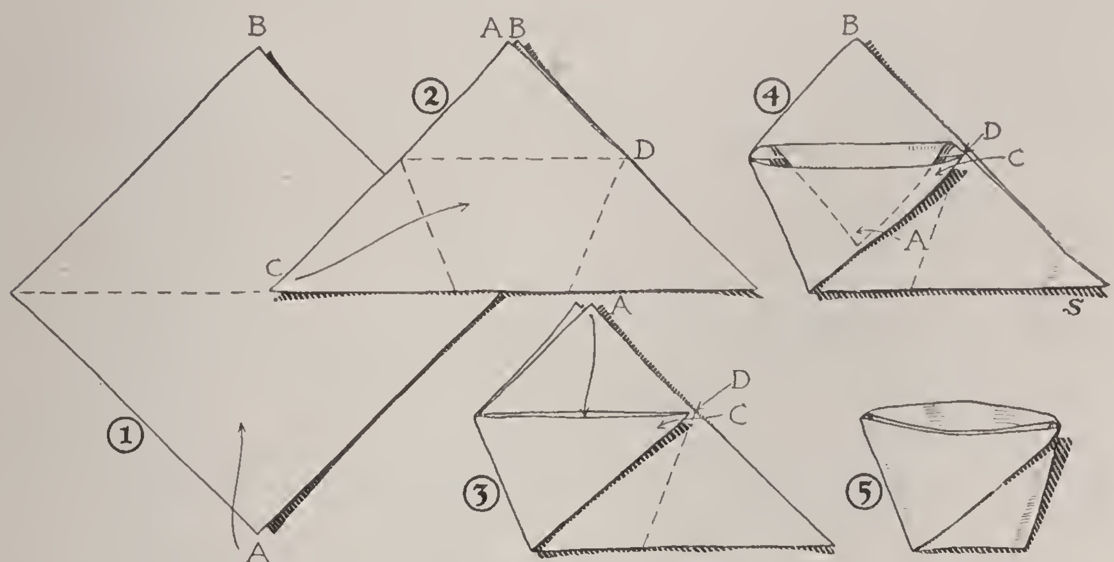


FIG. 16. The method of folding a square piece of paper to form a sanitary drinking cup. Crease paper diagonally, placing corner *A* exactly on corner *B*, as in (1) and (2). Place corner *C* exactly on the point *D*, making pocket as in (3); fold corner *A* into pocket thus formed, as in (4). Reverse the folded paper and carry out foldings on other side, completing the cup, as in (5).

5. How can you get the most good out of every bite you eat?

6. What less expensive foods could you substitute for some of the foods you eat now, and yet be just as well fed, or even better fed?

7. If you have ever had the heartburn, which is really a burning sensation in the stomach, what do you think brought it on?

8. Why do you think you ought to have a good deal of water at meal times?

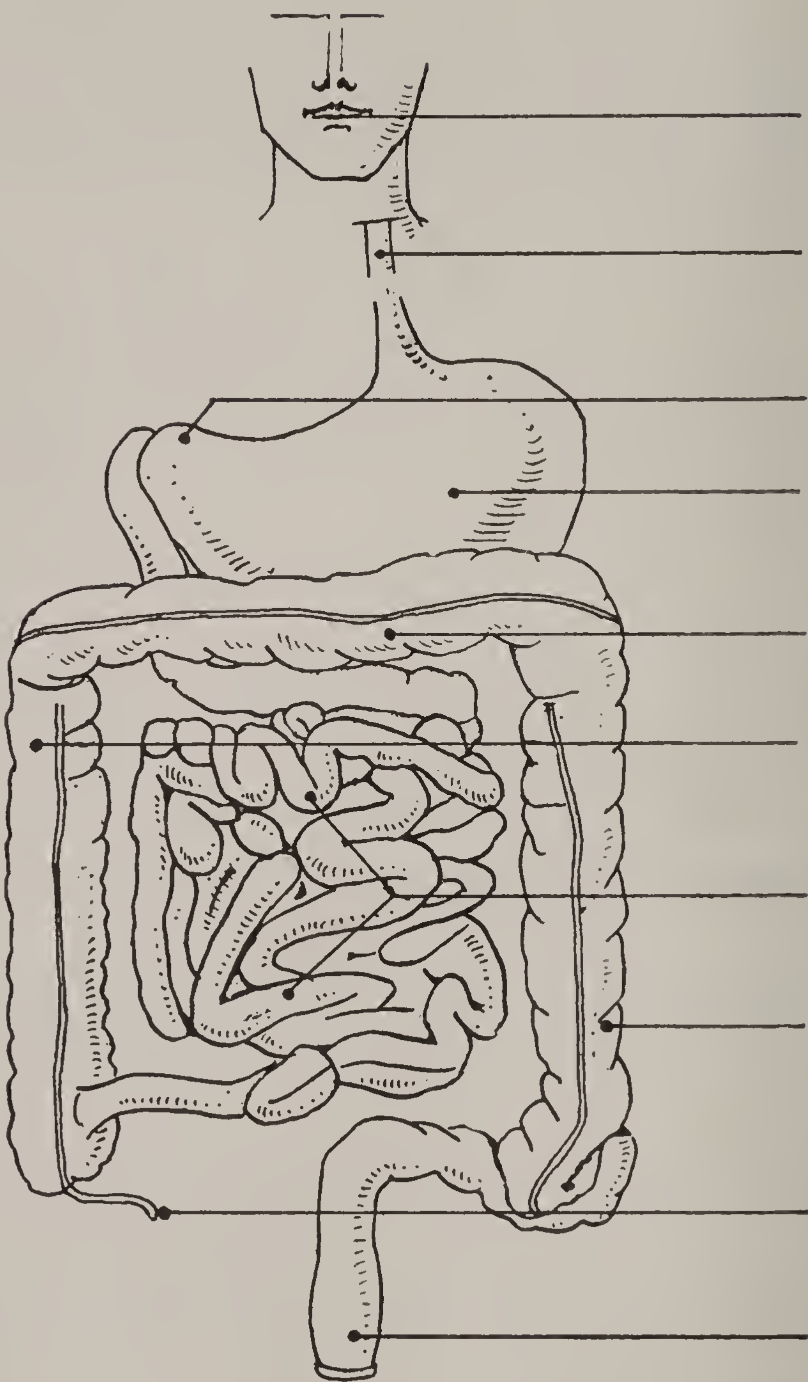


FIG. 17. Copy in your notebook this diagram of the organs of digestion. Then write at one side the names of the different organs and set down at the other side their uses.

9. What are two reasons why you should not wash food down or gulp it quickly.

10. What foods have you found to be harmful to yourself?

11. What foods have you found to be harmless?

12. What are ten rules for good manners at meals?

Exercise V. Questions for Investigation

1. At one side of the chart, Figure 17, write the names of the digestive organs, and at the other side write a brief statement of the chief use of each organ, as you learn these uses from other books.

2. How can you keep your digestive organs in good working order?

3. Why is milk one of the best of foods?

4. What are the three main kinds of foods, and what does each of these do for you?

5. Why should you learn to eat many kinds of foods?

6. What are vitamins?

7. Aside from the price, what determines the value of a pound of food?

8. Give at least three reasons why most foods should be well cooked.

9. Make a list of hygienic rules for eating and drinking.

STUDY SEVEN

TEA, COFFEE, ALCOHOL, AND TOBACCO

THERE are many things that are good to eat or to drink. But there are other things that are not so good, or that are even harmful. Most of us will leave off eating particular foods that we find hard to digest or that we know will harm us. But many of us keep on drinking tea and coffee in spite of the fact that they are harmful, because their bad effects do not show themselves quickly. Some men, too, who should know better, continue to use tobacco and stimulants. It will be well for us to find out just what is the harmfulness of some of the substances that people habitually use.

EXERCISE I. TEA AND COFFEE

1. **Finding a harmful stuff in tea and coffee.** If your school does not have a small scale, make a pair of

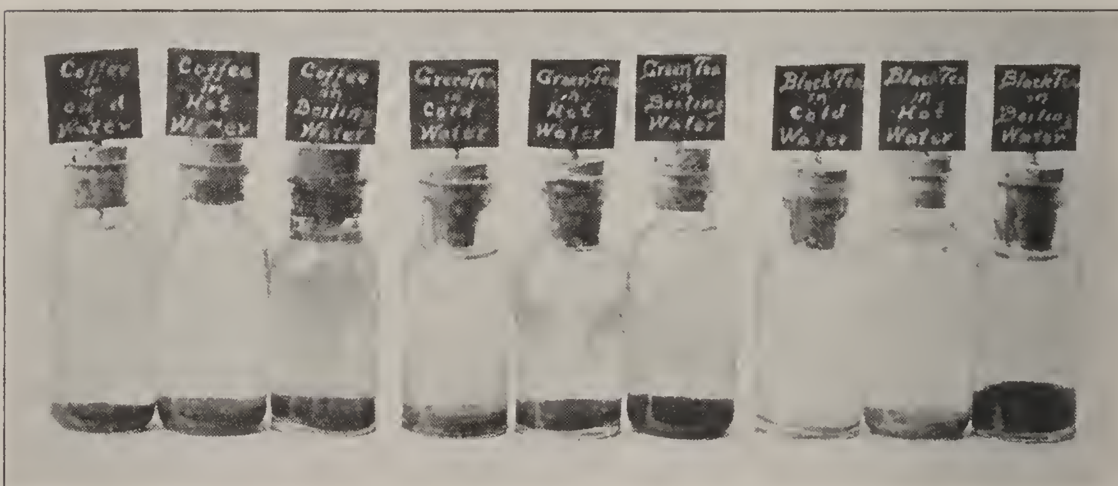


FIG. 18. Three of these bottles are filled with strained green tea, three with strained black tea, and three with strained coffee—each kind of tea and the coffee being made in three different ways. Some sulfate of copper dissolved in water has been added to the contents of each bottle. The deposits in the bottles show the relative amounts of tannin in the different beverages.

balances, using a ruler as a beam. Weigh out three samples of black tea, three of green tea, and three of freshly ground coffee, each equal to a dime in weight.

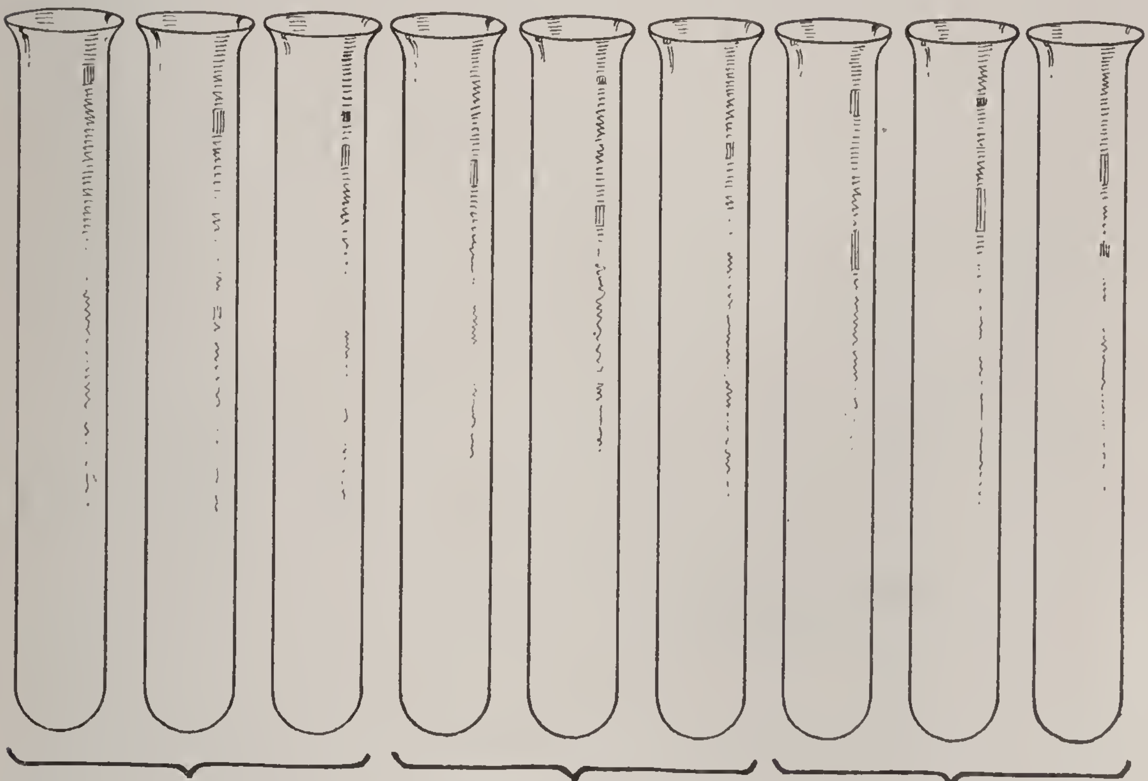


FIG. 19. Copy this diagram in your notebook, label each test tube, and indicate the tannin content for each of the beverages as variously prepared.

Distribute these samples in nine test tubes or in small and uniform wide-mouthed bottles. Nearly fill one of the test tubes or bottles in each of the three sets with cool or cold water, fill the second in each set with water that has just been boiling, and put boiling water into the third in each set; keep the water boiling in the last set for 3 minutes. Label each glass or bottle so that you can tell which is which.

You need next to strain off the leaves and grounds. To do this, take a tin cup and pour into it the contents of your first tube or bottle. Now strain the liquid

through a cloth back into the bottle from which it came. Do likewise with the remaining bottles. If the liquids in all the bottles are not now at the same level, equalize them by pouring a little of the liquid out of the bottles that are fullest

You are now ready to find out what the water dissolved from the tea and coffee. For this you need a strong solution of copper sulfate in water. Pour one teaspoonful of the solution into each of the nine glasses. A fleecy substance is formed in the glasses. Allow your nine glasses to stand for an hour. Then, from the outside, measure with a ruler the heights of the settlings in your samples of tea and coffee, and lay off and darken the respective heights at the bottoms of the drawings of the nine test tubes in the chart, Figure 19.

2. **The nature of tannin.** The fleecy substance which settled to the bottom of each of the glasses is called *copper tannate*, and since this compound was formed the tea and coffee must have contained a substance called *tannin*. Now this tannin is like ordinary alum in its effect on the linings of the mouth and stomach. Put a little piece of alum in your mouth and note its puckering effect. Why might tea and coffee do harm to the linings of the stomach and intestines?

3. **The stimulant in tea and coffee.** But people do not drink tea and coffee for the tannin there is in it. There is another substance which is called *the-ine* in tea and *caffeine* in coffee, that makes people want these drinks regularly. Caffeine and theine are exactly the same, and both substances may correctly be called "caffeine." Caffeine does not pucker the walls of the food canal, but it excites the nerves and makes one wider awake for a while. This is why it is called a *stimulant*. It makes a

great many people nervous and is often a cause of headache. It is particularly injurious to growing boys and girls.

Now this caffeine is present in tea and coffee in about the same proportion as the tannin, but the amount of caffeine given up is about the same whether hot or boiling water is used. What then, would be the best way to make tea or coffee in order to get the smallest amount of tannin?

Exercise II. Alcohol

1. **The appearance of alcohol.** Examine some denatured grain alcohol and find out what the word *denatured* means when applied to alcohol. What have you learned directly from seeing and smelling grain alcohol, and what is put into grain alcohol to denature it?

2. **The burning of alcohol.** Pour several drops of alcohol into a saucer and set fire to the alcohol. In what three ways does an alcohol flame differ from the flame of a burning match?

3. **Alcohol as a solvent.** Pour some alcohol on a fragment of varnished wood, some on a bit of rosin in a small bottle, and some on a few drops of oil in a small bottle. What happens when alcohol is poured on varnish, rosin, or oil?

4. **Alcohol and cell material.** The living cells that compose the human body are made of a material that is a great deal like the raw white of an egg. Pour alcohol on some raw white of egg. What does alcohol do to it?

5. **Alcohol and living flesh.** One can see how alcohol affects flesh by pouring alcohol on a small piece of fresh, lean meat. What effect does alcohol have on lean meat?

6. Testing for alcohol. Take about a teaspoonful of alcohol, pour it into a small bottle, and add 5 more teaspoonfuls of water. Now tie a wire to a little piece of sheet copper and heat the copper red hot. Continue heating until the copper, on cooling, will appear dark. While the blackened copper is still very hot, thrust it into the solution of alcohol. Remove the wire and see what has happened to it. Heat the copper again, and this time thrust it into pure water. Try this test on Peruna, Tanlac, or Lydia E. Pinkham's Vegetable Compound. How can you tell whether a liquid has as much as fifteen or twenty per cent of alcohol in it?

7. Another test for alcohol. Take the diluted alcohol used in the last experiment and bring it to a boil. Now hold a lighted match to the mouth of the bottle. In the same way, try samples of any of the patent medicines named above.

A. What is a second test for the presence of alcohol in a liquid?

B. What have you learned about some patent medicines?

Exercise III. Tobacco

1. Tobacco in water. Put about an inch of water into a small bottle. Then drop a piece of tobacco, about as big as a garden pea, into the bottle.

A. How do you know that water dissolves something out of the tobacco?

B. What is one of the substances the water dissolves? Look up the definition of *nicotine* in the big dictionary.

2. Tobacco in the white of an egg. Put another bit of tobacco on some raw white of egg. Recall that the cells of which the body is composed are made of a substance that is much like the raw white of egg.

A. Does the raw white of egg take up nicotine?

B. Would the cells of the body be likely to take up nicotine?

3. **Effect of nicotine on small animals.** Put a drop of tobacco solution on a fly or other insect that is a pest. What happens to the insect?

4. **Effect of nicotine on skin.** Put two or three drops of tobacco solution on your little finger where it is white and clean. How does the liquid change the color of your finger?

5. **Vaporization of nicotine.** Take a bit of tobacco no larger than a pea and place it on a thin metal plate supported over a flame. Note the odor. How do you know that nicotine vaporizes when heated?

6. **The fumes of nicotine.** Stick a piece of tobacco as big as a garden pea on the end of a wire or a hatpin and thrust it into a flame. Is the resulting odor different from the odor that you noticed when you heated a bit of tobacco?

Exercise IV. Questions on the Foregoing Exercises

1. What use do barbers sometimes make of alum?
2. Why is baking powder that has alum in it thought not to be healthful?
3. Which has the most tannin in it, and which has the least, black tea, green tea, or coffee?
4. What is alcohol?
5. Why should you look carefully at a label on a patent medicine bottle before you even consider taking any of the medicine?
6. What is lemon extract? Witch hazel extract?
7. Why do housewives sometimes sprinkle a solution of tobacco on house plants?

Exercise V. Questions for Investigation

1. Why are boys and girls better off if they do not drink tea or coffee?

2. What two digestive organs are most harmed by the use of alcohol?

3. How does tobacco affect the heart?

4. How does the pulse beat of a smoker differ from that of a non-smoker?

5. How does tobacco affect the digestive organs?

6. How does tobacco affect the nervous system?

7. How does tobacco affect the work of pupils in school?

8. Why do managers of football teams not permit their men to use tobacco?

9. What are some habits that one should *not* form?

STUDY EIGHT

THE BLOOD AND ITS CIRCULATION

YOUR study of foods and drinks no doubt has brought to your mind several questions. How does the food get to the parts of your body that need it? What happens to the food when it gets to those parts, and what becomes of the waste material that is replaced? These are some of the things you will now have a chance to find out about.

EXERCISE I. WHAT BLOOD IS LIKE

1. **Blood seen through a microscope.** If the school has no microscope, your teacher or one of your classmates may be able to borrow one for a day, perhaps, from a

FIG. 20. To examine human blood, a drop of it is placed on a little piece of glass. This glass is covered with another glass that is very thin. The prepared "slide" is then placed on the stage of a compound microscope.

physician. The teacher will then place a tiny drop of fresh human blood on a slide and cover it with a cover glass. Set the microscope so that it will magnify a

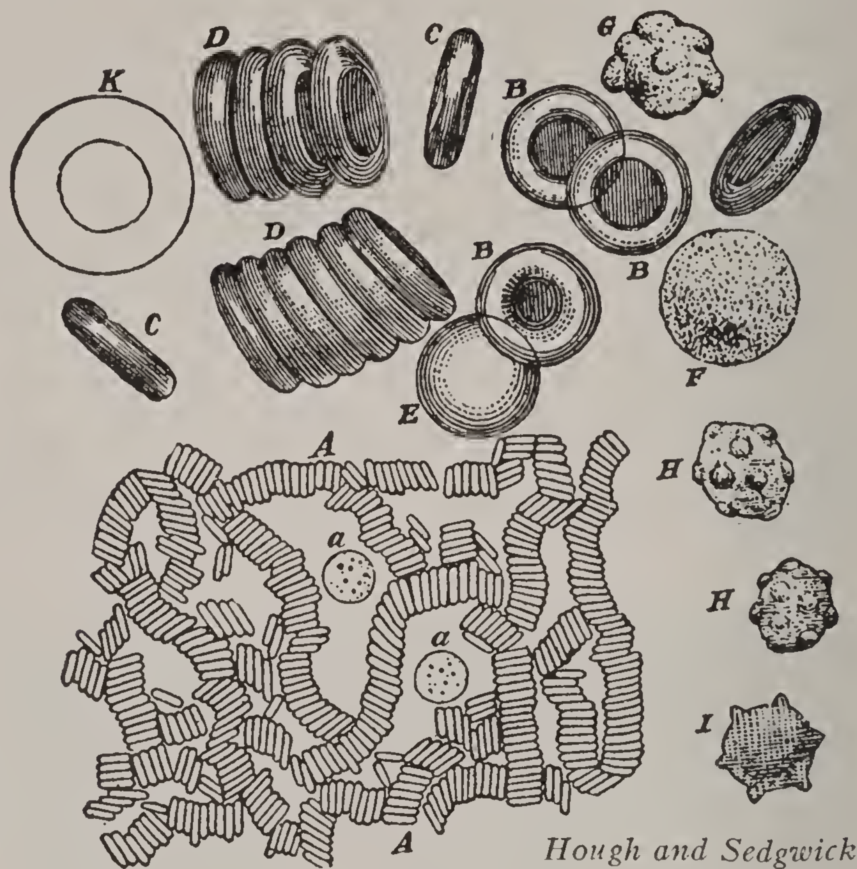


FIG. 21. Corpuscles found in human blood, highly magnified. A red corpuscle is shaped about like a circular piece of mint candy, thinned at the center to leave a heavy rim all around. The white corpuscles are not regular in shape.

hundred times. As you look at the blood mounting through the microscope, you should now see numerous tiny, pale, yellowish-red bodies floating in a liquid. The liquid is called *plasma* and it carries food and waste. The reddish bodies are called *red corpuscles* of the blood. They serve to carry around to the different parts of the body a gas called *oxygen*, which the body needs for its work.

2. **Examining clotted blood.** Let somebody bring to class a small bottle of fresh blood from a chicken. Then allow the blood to stand until it clots.

A. What do you think the most of the red mass of clotted blood is made of?

B. The liquid that gathers around the outside of the clot is a little different from plasma because the plasma lost a small part of itself in helping to make the clot. The liquid is now called *serum*. What does the serum look like?

Exercise II. How the Blood Circulates

1. **Studying pulse waves.** Take off the bulb and tube from an atomizer, a little instrument that can be gotten at a drug store. The tube should be at least a foot long. Fill the bulb with water, and then, while squeezing the bulb with one hand, hold the rubber tube lightly between the thumb and forefinger of the other hand. Notice the wave of water that runs along the tube. Squeeze the bulb several times, first quickly and then slowly. What is the difference in the two kinds of outgoing waves that run along the tube?

2. **Counting your pulse.** Place the ends of the first and second fingers of your right hand on the inside of your left wrist, an nch or more above the root of the thumb. Feel around until you find a good pulse or wave of blood. Count the pulse waves per minute in each of the following cases:

A. When you have been sitting quietly for a while.

B. After you have been running hard for a couple of minutes.

3. **Relation of heartbeat to pulse beat.** Place your finger tips at the lower end of your breastbone and then

move them an inch or more to the left until, between the forward ends of the fifth and sixth ribs, you can feel the lower point of the heart beating against the chest wall. The rest of your heart is *above* and to the *right* of this beating point. Your stomach is just below this point.

Press the finger ends of one hand against the beating spot of the heart, and press the finger ends of the other hand against the big pulse in the neck by the side of the voice box.

A. If the pulse beats in the neck and over the heart do not come at exactly the same time, which one of them is a bit ahead of the other?

B. How do you account for this difference in time of these two pulses?

4. **Relation of age to pulse.** What is the pulse beat frequency per minute of people of about the following ages, when they are sitting quietly: One year or less? ten years? thirty years? sixty years?

5. **Sounds from a heartbeat.** Listen to the beating of somebody else's heart by placing your ear against the chest about an inch to the left of the very center of the breastbone.

A. When listening to the beating of a heart, do you hear two different sounds, one right after the other?

B. Which sound is short and sharp, and which sound is long and dull?

Exercise III. Questions on the Foregoing Exercises

1. What makes the blood soon stop flowing from a slight wound?

2. How can you tell if the blood from a wound is coming from an *artery*, a vessel carrying blood *from* the heart?

3. From a *vein*, a vessel carrying blood *to* the heart?

4. Since your blood carries oxygen around to your muscles to set energy free for motion, why does your heart beat oftener when you are running?

5. Why do you have to open your mouth to breathe while running very hard?

6. Why cannot people with weak hearts run long at a time or very fast?

7. What effect does age have on the rate of a person's heartbeat?

Exercise IV. Questions for Investigation

1. What is blood for?
2. What is the heart for?
3. What are the arteries for?
4. What are the veins for?
5. How does the blood get over to the arteries from the veins?
6. How does the food in the blood get out among the body cells?
7. Why should you not exercise your heart too much, as in hard games and long-distance running?
8. How can you stop the bleeding from a wound?
9. How can you stop nose bleeding?
10. What habits should you form to benefit the heart and to keep a good blood circulation?

STUDY NINE

CARING FOR THE SKIN

We most naturally think of the skin as the covering of the body. The skin, together with the hair and nails and eyes is all that we see of one another; and there is some truth in the old saying, "Beauty is only skin-deep." But the skin has several uses besides serving as a body covering. In this study we shall consider what its several uses are.

Exercise I. Studies of the Skin

1. **The skin magnified.** Use a strong simple magnifying glass to examine the skin of your hand. Notice how scaly it looks. When the hand is sweaty, scrape some of the scurf off the skin. What is this scurf, and why can you never free your skin of it entirely?

2. **Why skin smells bad.** Recall the smell of decaying flesh, as of a dead cat, rat, or other decomposing animal.

A. Does human skin smell bad sometimes?

B. Why does clothing, especially that worn near the skin, sooner or later get to smelling bad?

C. What is better than perfume to kill body odors?

3. **Washing and bathing.** Some time when your hands are not very clean, wash them as well as you can in clear water. Smell the hands to see if there is any odor. Now wash them again, using unscented soap and warm water.

A. Why do the hands smell better after they have been washed with plain soap and water?

B. What is really the reason why you should bathe?

C. How often ought you to bathe?

4. **The effect of soap on oil.**

A. Put several drops of oil on some water in a small bottle and then shake the bottle. Let the bottle stand

FIG. 22. These children are allowing their skins to get training that will help their bodies to guard against colds. Of course, care must be taken to avoid getting chilled while enjoying such a bath on the lawn.

for a while and note what the oil does. Into a similar bottle put some very soapy water and add several drops of oil. Shake the bottle and let it stand for a short while. What happens to the oil in each bottle?

B. Poison ivy is a plant whose leaves and stems give off a volatile oil that irritates the skin. Why should one immediately wash any parts of his body that may have come in contact with the ivy, using plenty of soap?

EXERCISE II. WHY THE SKIN NEEDS VENTILATION

1. **Seeing sweat pores.** Look through a magnifying glass at the skin in the palm of your hand. Notice the little ridges. Now look very sharply for tiny depressions along the tops of the ridges. These are the outlets of the sweat pores of the skin. A tiny droplet of sweat may be seen at the outlet of each pore. Similar depressions

occur all over the skin, but they are not so easily seen elsewhere. In your notebook make a large-scale drawing of one of the tiny ridges on the palm of your hand, showing the depressions where the sweat comes out.

2. **Insensible perspiration.** On a day when the temperature is below 50 degrees Fahrenheit, or in a place where you can get that temperature, put your hand into a Mason fruit jar, in which you have first placed a thermometer. Do not allow the skin to touch either the sides of the jar or the thermometer. Stop up the unoccupied part of the jar with a handkerchief. When you have held your hand in the jar for perhaps a minute, note that the temperature on the inside of the jar is still only about ten degrees warmer than that on the outside. After five or ten minutes note the appearance of the inner surface of the jar. What have you learned from this experiment?

3. **Effect of volatile liquids on the skin.** Pour a few drops of ether, alcohol, or gasoline, on the palm of your hand. Pay no attention to the odor, but notice only whether the hand feels cold as the liquid quickly evaporates from the surface of the skin.

A. When does the spot where the liquid was poured cease to feel cold?

B. Why does not the liquid itself feel so cold when you put your finger into it?

4. **Effect of vaporization on temperature.** Insert the lower end of a dairy thermometer into a small bottle of ether, alcohol, or gasoline, and note the temperature of the liquid. Now remove the thermometer and watch the movement of the mercury column as the liquid evaporates. Watch the mercury for a minute or more after the liquid has evaporated entirely.

A. As the liquid was evaporating from the bulb of the thermometer, what was the effect on the temperature of the thermometer?

B. What is the effect of rapid evaporation on temperature?

C. Why did the liquid in Experiment 3 make your hand so cold?

D. Since you perspire when you are very warm, what do you think is the main reason for your perspiring at all?

5. **Effect of air in motion on vaporization.** In a moderately warm room put two or three drops of water in each of two saucers. Keep the air in motion over one saucer by fanning. Notice how many minutes it takes for the water to evaporate from each saucer. What seems to be the effect of moving air on evaporation?

6. **The effect of motionless air on skin temperature.** Put on a raincoat that is much too large, keeping it away from the body with a square wooden frame that rests on the shoulders, as in Figure 23. Take the temperature of the inside air. Now let some one take hold of the coat at the frame, giving the coat a swinging motion until the air is well stirred inside. Take the temperature once more.

A. What was the thermometer reading at the beginning of the experiment? at the end of the standing still? after the air had been set in motion?

B. Did you feel much cooler when the coat was swinging than when it hung still?

C. Recalling the experiment with the drops of water on the saucers, what do you think made you feel different when the air was stirred on the inside of the coat?

D. What is a very important reason for ventilating a living room?

7. **The skin a source of odors.** Let the person who is

working with you, in taking the raincoat off from you, be sure to unbutton it at the top only, and slowly lift the coat up over your head, so as to give you a chance to note the odor of the air that has been inside the coat.

A. What makes the air of a crowded room smell bad?

B. For what other reason than cooling the body when warm should a living room be kept well ventilated?

C. If everybody were to keep reasonably clean, would

FIG. 23. Why is it that the air in a room that is occupied needs to be kept in motion? The little girl shown here is submitting to an experiment that will give the answer.

it be as necessary as it now is to ventilate the average living room?

Exercise III. Questions on the Foregoing Exercises

1. State two important uses of the skin as shown by the above experiments.

2. Since it is not quite true, as some people have said, that we sweat to throw off waste matter, what shall we say is the important reason we perspire?

3. A Nebraska farmer and his hired hands take shower baths and put on clean overalls just after the day's work is over and before going in to supper. What do you think of this way of doing; namely, cleaning up before the evening meal?

4. What are two important reasons why a living room needs to be ventilated?

Exercise IV. Questions for Investigation

1. What are the parts of the skin?

2. What four different kinds of sensation does one get from the skin?

3. How does the skin help to regulate the body temperature?

4. Why should you bathe?

5. Which is better, to use perfumes to hide bad odors, or to take a bath and remove the source of the odors?

6. What are some good habits to form in caring for the skin?

STUDY TEN

TAKING CARE OF THE FINGER NAILS, HAIR, AND SCALP

WHY do you have finger nails and hair? If you did not have them, you would at least not have to bother to get them trimmed. What a relief it would be not to have to comb your hair when you get up in the morning! Still, baldheaded people do not seem to enjoy being baldheaded. There must be some use for hair, after all, and for nails, too. What can these uses be?

EXERCISE I. STUDIES OF THE FINGER NAILS

1. **Facts about the nails.** Make a study of your finger nails to find out answers to the following questions:

A. How do your nails differ from your skin?

B. What two reasons can you give for believing that nails steadily grow out from the roots?

C. Does a nail get thicker the farther it grows out from the root? Find out by pressing with a dull pencil point at various places on the nail.

D. How do the three parts of your nails differ in color — the base or part rising from the root, the central part or body, and the outer part or free margin?

E. Since the nail itself is not pink as seen at the margin, why do you think the central part looks pink?

F. Since the margin of the nail itself never really gets black, what makes it look black sometimes?

G. Why could you not get along very well without finger nails?

2. **Caring for the roots of nails.** Sometimes you find that the skin at the root of a nail hangs to the base of the nail. It may even hang on so long as to be partly pulled away from the rest of the skin as the nail continues to grow. This makes the nail look very ragged.

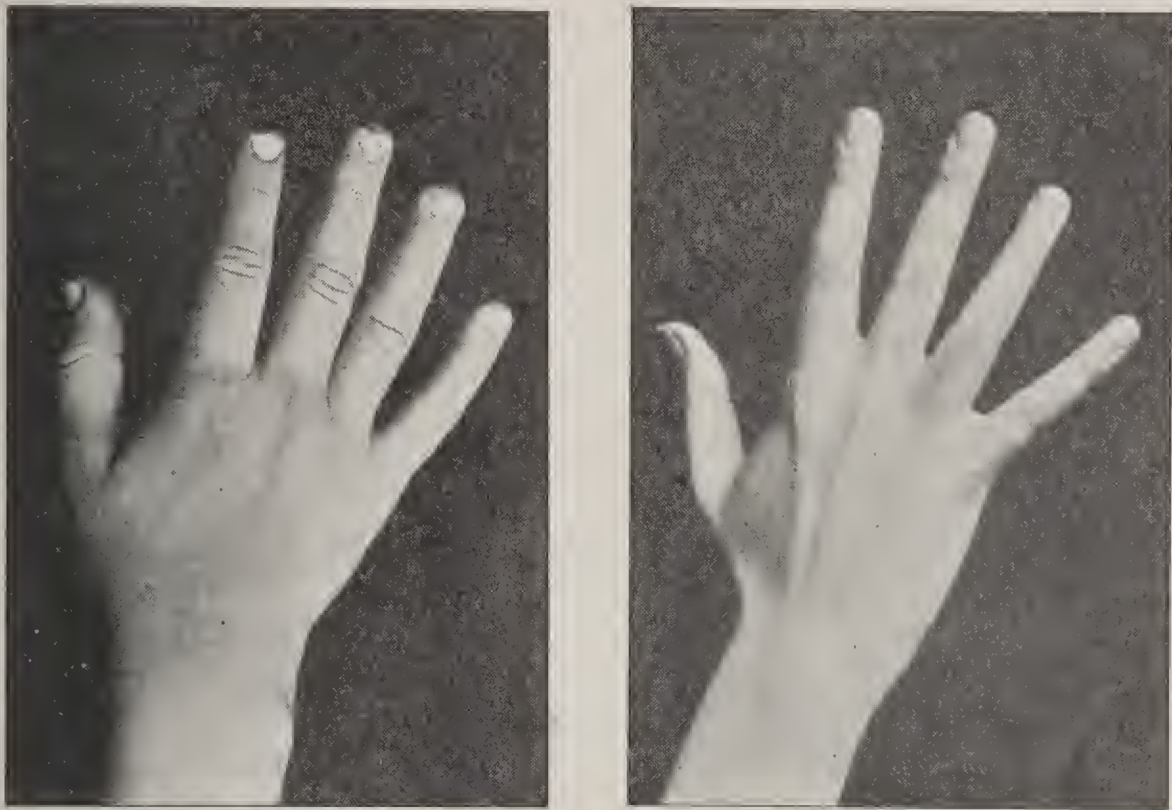


FIG. 24. At the left is shown the hand of a nail biter, and at the right is shown the hand of a person who has never bitten the nails. Which kind of hand should you prefer? A nail clip that may be bought for a dime or a quarter will save fingers, teeth, and self-respect.

A. What can you do to keep the skin from clinging to a nail at the base?

B. How can this best be done without injury to skin or nail?

C. What have you found to be the best thing to use in trimming your nails?

D. After studying Figure 24, why do you think you should avoid the habit of biting your nails?

EXERCISE II. STUDIES OF THE HAIR AND SCALP

1. **Examining a hair.** Secure a hair freshly pulled from your head and examine it with a microscope or a strong magnifying glass.

A. Is a hair smooth or is it scaly?

B How does the root seem to differ from the rest of the hair?

2. **Hair in relation to the scalp.** Look closely at the hair of some one's scalp. Does a hair seem to come from any depth in the scalp or only from the surface?

A. How is a hair fastened to the scalp?

B. What matter do you find on the scalp that looks like the scurf that you scraped from the back of your hand?

3. **Effect of rubbing the skin.** Using a clean handkerchief, rub the back of your hand vigorously until the skin begins to redden.

A. Remembering that blood feeds the hair roots, what advantage do you think there may be in thoroughly brushing your hair and scalp once or twice a day?

B. What is the objection to wearing a hat so tight that it cuts down the circulation of blood in the scalp?

4. **One cause of headaches and its cure.** When you have a headache, you can sometimes get relief by rubbing the scalp well. Most headaches are due to poisonous matter in the scalp, and rubbing helps the blood to flow along and take away the poison. This poison usually comes from overworking the muscles in case of bad eyesight, from decaying food in the bowels, from fatigue due to loss of sleep and rest, or from foods that should not have been eaten.

A. How often do you have headaches, if at all?

B. What do you think causes them in your case?

C. How then can you keep from having headaches?

Exercise III. Questions on the Foregoing Exercises

1. Keeping track of the time that it takes for a "black and blue" mark, or other mark, at the base of the nail, to

grow out to the end of the nail, about how long do you find that it takes a finger nail to grow out?

2. Why is biting the nails a habit that is bad for the mouth? Why bad for the teeth? Why bad for the nails?

3. What is meant by the phrase "massaging the scalp"?

4. Why, in taking care of your hair, should you brush it vigorously and for some time?

5. What do you suppose is the reason for baldness in some cases?

6. Should you take headache medicine when you have a headache, or should you remove the cause of the headache?

7. Does a headache ever serve a useful purpose?

Exercise IV. Questions for Investigation

1. How do your nails get longer and thicker?
2. How should your nails be trimmed?
3. How does your hair grow in length?
4. How is your hair oiled naturally?
5. How should your hair be cared for?
6. Why should you not use a public comb and brush?
7. What health habits are necessary for the good of nails, hair, scalp?

STUDY ELEVEN

USES OF CLOTHING

Beau Brummel was a famous English dandy of a hundred years ago. In a play based on his life he is made to say something like this: "What a blessing that the Lord gave us our bodies bare that we might dress them to suit ourselves!" A good many people seem to have this same idea — that clothes are mainly for ornament. Nevertheless, the most important reason for wearing clothing has to do with the hygiene of the skin. The barbarian in lands where the weather is always hot wears only a loin cloth, while the Eskimo keeps himself clothed in furs. Both of these dress according to the climate, and in that respect they practice hygiene. For ornament, the Eskimo will have his furs embroidered, but he will not cut scallops in his coat or "parka"; and the man with the loin cloth will put a brass ring in his nose, but he will not wear summer furs. The people of some civilized lands are not always so sensible as these backward peoples in this matter of dressing as the hygiene of the skin requires. To dress in the most hygienic manner, we need to know something about clothing materials as well as about the body and its needs.

Exercise I. Properties of Different Textiles

1. **Preparing several textiles for study.** For a study of clothing materials, you will need pieces of cotton, linen, and silk, each about the size of a man's handkerchief; also a piece of thin woolen goods weighing no more than the piece of cotton cloth. If scales for weighing as little as an ounce or less are not at hand, take a light wooden

FIG. 25. The girls here are examining various textiles. The boy has rigged up a balance on which he will get four pieces of cloth to weigh the same.

ruler, stick a pin through the exact center, pin the piece of cotton cloth to one end of the ruler, and trim the woolen piece to such a size that, when pinned to the other end of the ruler, it will balance the cotton piece exactly. If silk and linen pieces of cloth are not to be had, these experiments can be performed to advantage with cotton and woolen cloth alone. There will also be needed for the experiments a common drinking glass three fourths full of water, a kerosene lamp, a simple magnifying glass, and a pan of water.

2. **Testing the heat conductivity of textiles.** You need first to study the power of the pieces of cloth to conduct heat. The sample of silk should perhaps be doubled to make it as thick as the samples of cotton, wool, and linen. Place a part of the cotton cloth over the end of the index finger and then rest the finger against the chimney of a burning lamp at a point about a third of the way

down from the top of the chimney. Note the number of seconds that pass until the finger end gets too hot for comfort and is pulled away. Try in the same way the heat conductivity of the samples of wool, silk, and linen in each case, keeping track of the number of seconds till you have to pull your finger away from the lamp chimney.

A. How many seconds did your finger stand the heat for the cotton? for the wool? for the linen? and for the silk?

B. Which of the cloths is the best conductor of heat, and which is the poorest conductor of heat?

3. **Conductivity of a metal and of air.** With one index finger, hold a copper penny at the same spot on the lamp chimney against which you held the cloth. The end of the other index finger should be held near the lamp chimney, on the opposite side, leaving a space that corresponds to the thickness of the penny.

A. Is copper as good a conductor of heat as air is?

B. Is copper as good a conductor as cloth is?

C. Is air a good conductor, or is it a very poor conductor of heat?

4. **Effect of crinkly fibers on conductivity.** With a simple magnifying glass, examine the finest possible fiber you can get from each of the samples of cloth.

A. Which of these textile fibers looks coarsest and crinkliest when magnified, and which looks finest and least crinkly?

B. Note that crinkly fibers cause a lot of air to be enclosed in a textile. What effect does this have on the conductivity of the textile?

C. What is the effect on the conductivity of cotton when it is woven with meshlike structure, as it sometimes is in underclothing?

5. **Water absorption by different textiles.** You learned in your studies of the skin that you perspire mainly in order to get rid of the extra heat in the body. That this loss of heat may go on best, the underclothing should be of textiles that will most quickly take up and pass on the perspiration. You must, therefore, test your textiles to find out their relative power to absorb water. To do this, suspend the four samples of cloth so that an inch at a lower corner of each piece is in a glass of water by itself, the top corner being pinned to a suitable support above. After the textiles have hung for a little while with ends in the water, what do you find to be their relative powers of absorption; that is, which textile is the best absorber of water (is damp highest up), which is second best, which third best, and which fourth best?

6. **Water-holding power of textiles.** The relative water-holding power of each sample of cloth is worth finding out. You can discover this by pressing down each piece, when it has dried, into a separate drinking glass three fourths full of water, this level having been marked with an ink line on the outline of the glass. When taking each cloth out, allow it to drip as much water back into the glass as it will. Be sure, too, that each textile has become thoroughly soaked before removing it from the water. Now compare the loss of water from each glass to see the relative water-holding power of each textile. Which textile is first in water-holding capacity? Which is second, which third, and which fourth?

7. **Loss of water from textiles.** It now remains to find out which textile loses its water fastest, for that is important also. Take the four pieces of wet cloth and hang them up where they will dry. Watch closely to see which

one dries first. The silk will usually have the advantage here because it is thinnest and most spread out. But note especially the cotton and the wool. Which textile dries first, which dries second, which third, and which fourth?

Exercise II. Good Textiles for Outer Clothing

1. **How to tell animal from vegetable fibers.** In an earlier study you learned the difference in textiles by examining fibers under a magnifying glass. You can also tell the kind of fiber of which a piece of cloth is made by putting an end of the cloth into a drinking glass partly filled with a water solution of potassium hydroxid. This chemical will dissolve woolen and silk threads, which are animal fibers; but it will not dissolve cotton and linen threads, which are vegetable fibers. Let some pupil show the rest of the class how this works out. How can you tell animal from vegetable fibers in any textile?

2. **Distinguishing cotton from linen.** Sometimes it is a little troublesome to decide with certainty whether a piece of cloth is cotton or linen. But there is a test that you can easily apply. Put a drop of glycerin on a piece of each kind of goods that you have been experimenting with, and let the goods lie for a few minutes. Which kind of cloth lets light go through best when glycerin is put on it?

3. **Clothing and body warmth.** Whether clothing in itself gives any warmth to the body, an experiment can be made to show. For this experiment you will need two big bottles with water equally warm in them and two with water equally cold in them. You must now wrap a woolen cloth around one of each pair of bottles,

leaving the other bottles unprotected. After a little while, use a dairy thermometer to see if there is any difference in the temperature of the two cold bottles and likewise of the two warm bottles. Which of the warm bottles stayed the warmer, and which of the cold bottles stayed the colder? What did the woolen cloth do for both bottles?

Exercise III. Questions on the Foregoing Exercises

1. Why does a cotton sheet feel so much colder on your bed in winter than a woolen blanket?
2. Why does a piece of iron feel colder to your touch than a piece of wood, when both are lying out-of-doors in winter?
3. How can cotton underwear be so woven as to make it as good a non-conductor as woolen underwear is?
4. Which kind of underwear can take up perspiration more quickly, cotton or woolen?
5. Which kind of underwear can hold the larger amount of perspiration, cotton or woolen?
6. Which kind of underwear can give up its perspiration more quickly, cotton or woolen?
7. Which is the cheaper, cotton underwear or woolen underwear?
8. As to ease with which underwear can be laundered, which is the better for underwear, cotton or wool?
9. What are five reasons why cotton underwear is better for most people than woolen?
10. What are two ways to tell cotton cloth from woolen cloth?
11. What are three hygienic reasons why we wear clothing?

Exercise IV. Questions for Investigation

1. Why do people living and working in warm houses in winter time not need to wear very much heavier underclothing in the winter than in the summer?

2. How should such people prepare to go out into the cold?

3. Why should you not keep on your overcoat or cloak and your overshoes, when coming out of the cold to remain for some time in a warm room?

4. What should you do if your clothing or shoes get wet, especially in cold weather?

5. Make an outline here of a sole of a shoe that is hygienic in shape.

6. What health habits should you practice with regard to clothing and footwear?

STUDY TWELVE

THE BRAIN AS THE HOME OF THE MIND

WE occasionally hear it said of a man that he has brains or that he lacks them, and we take the remark to mean that the man has a good mind or a poor one. The idea is correct, too, that the quality of the mind depends on the quality of the brain. To make clear some points about the mind that we have so far taken for granted or not known at all, we shall devote this Study to the brain.

Secure the fresh brain of a slaughtered animal, as a sheep or a hog. Try to get it with as much of the spinal cord and as many nerves attached to it as may well be. Keep the brain in a ten per cent solution of formaldehyde for a few days to sterilize and harden it before using it for study. Of course, a brain model can be used, but it will not be so satisfactory as a real brain.

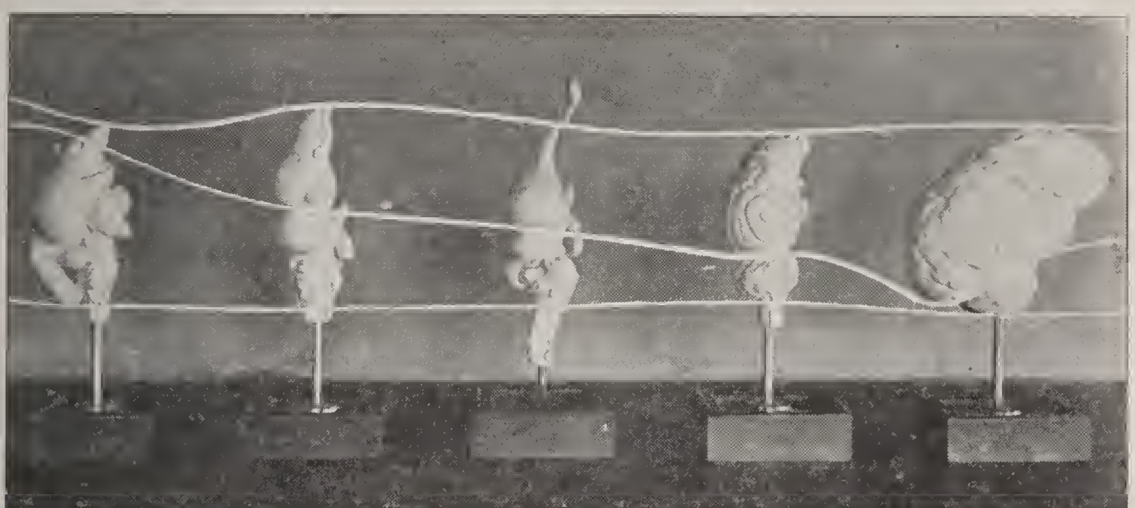


FIG. 26. Models of the brains (left to right) of a fish, a frog, an alligator, a dog, and a man. Notice how the proportion of the brain used for learning becomes larger and larger as we pass from the lower animal groups to the higher. The models shown are not in scale, of course.

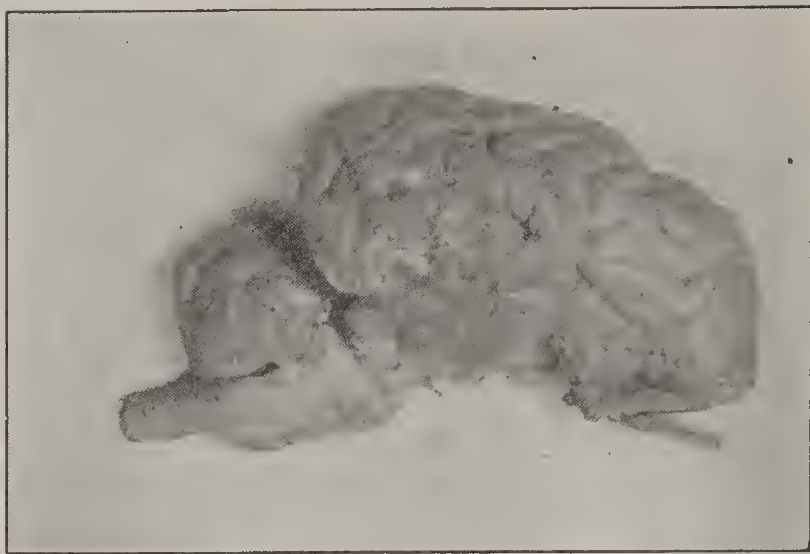


FIG. 27. Side view of a sheep's brain. In your notebook make a simple drawing of this brain, and then label the various parts of the brain as they are described in the text.

EXERCISE I. LEARNING ABOUT THE BRAIN AND NERVES

1. **The cerebrum.** Examine the largest part of the brain, the forebrain or *cerebrum*, consisting of two parts or *hemispheres* separated by a deep fissure. This is the part of the brain that works most when you have sensations and when you have ideas. This is also the part of the brain that is used when you perform a willed act, that is, an act controlled by an idea. It is the seat of "common sense," that is, of good judgment about common things. It may be used to control the rest of the brain and nervous system, and it is what keeps you from being a mere animal. Whenever you control your anger or your fear, your top brain is working at its best. Write a little description of the cerebrum as you have seen it.

2. **The cerebellum.** The next largest part of the brain is called the "little brain," or *cerebellum*, which has a great deal to do with habits, and with the power to

FIG. 28. The half of a sheep's brain that has been cut in two the long way, to show the inner parts. Make a drawing of this section and label the parts.

balance your body. Write a little description of the cerebellum.

3. **The medulla oblongata.** The cerebellum is fastened to another part of the brain called the *medulla oblongata.* This medulla oblongata takes care of the breathing, digestion, heart action, and circulation. It also controls many of the workings of the body that help you to grow and be healthy. Write a little description of the medulla.

4. **The spinal cord.** Find the stump of the spinal cord at the lower end of the medulla. If the spinal cord were all there, it would be as long as the backbone of the animal. The spinal cord is the part of the nervous system that takes care of a great many little acts that you do not have to think about, such as jerking your hand back after touching a hot stove. Acts like this are called *reflex* acts. Write a little description of as much of the spinal cord as you can see.

5. **The nerves.** It may be that stumps of nerves will

be found coming out from the medulla oblongata of the brain you have been examining. Nerves are white, coarse fibers that serve to carry messages between the brain and the spinal cord on the one hand, and the parts of the body on the other. Write a little description of the stump of a nerve, if you find one.

6. Summary. Label the parts and set down the uses of the brain as shown in Figure 27.

7. The inside of the brain. Now cut the brain in two, the long way. Lift up the rear end of the cerebrum and note that it covers a big, whitish lump as big as the outer joint of your thumb. This is called the *thalamus* and it is a very interesting and highly important part of the brain. It is the part of the brain that works most when an animal becomes frightened, or angry, or cries; that is, it is the seat of instinctive behavior. It is also the seat of feelings, and is active when one feels good or bad. When a human being gets excited and acts as lower animals do, his cerebrum has about quit work and only his thalamus and other lower parts of his brain are in action. Label and write down the uses of the parts of the brain pictured in Figure 28.

Exercise II. Learning about the Senses

1. The sensations arising in the skin. Touch your hand to a warm object. This gives a sensation of warmth. Touch your hand to a cold object. This gives a sensation of cold. Place your finger against some object that is neither hot nor cold. This gives the sensation of touch or pressure alone. Gently press a pin point against the skin. The sensation of pain arises. These are the four sensations coming from the skin.

A. What do you think a sensation is?

B. What are the four sensations from the skin?

C. How may pain be a kindness of nature?

2. **The sensations from the tongue.** Put sugar on your tongue, then common salt, then drops of vinegar or lemon juice, and finally a very tiny bit of quinine. What are the four taste sensations that your tongue may give you?

3. **The sensations from the eye.** Take a small piece of very bright red paper, about as big as a cent, and lay it on a larger piece of white paper. Make a dot in the center of the piece of red paper, and look at this dot very steadily while you count 40. Now look at some spot on the white paper. The color that you now see as you look at the white paper is the second of the six primary eye sensations. In a similar way look at a piece of blue paper on the white sheet, and then at a piece of very black paper. What are the six primary sensations of the eye?

4. **The sensations from the ear.** Strike single tones on a musical instrument, and then strike a lot of tones all together. What two different kinds of sensations come from the ear?

5. **Other sensations.** Write in your notebook the names of as many other sensations as you know.

Exercise III. Questions on Mental Hygiene

1. What do you think your mind is for?

2. What is meant when people talk to you about improving the mind?

3. Why must we have sleep?

4. At what time do you usually go to bed? At what time do you usually get up? About how long, then, do you sleep every night?

5. Do you always have a window open while you sleep?

6. If you have ever started to get angry and then decided to keep calm, what part of your brain did you bring into use?

7. When children become angry easily or pout a great deal, how can they be made to get over such bad habits?

8. Is it possible for one who is scared easily to get over this unfortunate tendency?

9. How can a "cry baby" cease to be such a person?

10. If a boy or girl has an unhappy disposition, what do you think he or she could do to be freed from it?

11. How could a boy who "thinks he's smart" make himself more agreeable to his playmates?

12. What are some ways of doing that will help you to be cheerful during a greater part of the time?

Exercise IV. Questions for Investigation

1. What is the nervous system?
2. What is the work of the brain?
3. What is the work of the spinal cord?
4. What two different kinds of work do nerves do?
5. Why do you need rest after hard work?
6. How long should a boy or girl of your age sleep?
7. What is the use of a sensation of pain?
8. What useful purpose do headaches serve?
9. What are some of the things that cause headaches?
10. What is a habit?
11. How can you break a bad habit?
12. How can you form a good habit?
13. Make a list of good habits of mind and behavior.

STUDY THIRTEEN

TAKING CARE OF YOUR EYES AND EARS

DOUBTLESS you know something of the story of Helen Keller, that wonderful woman who is both blind and deaf. In one of her books she says: "My hand is to me what your hearing and sight together are to you. It is the hand that binds me to the world of men and women. The hand is my feeler with which I reach through darkness and seize every pleasure my fingers touch."

People who nave good eyes and ears do not realize how useful and at the same time how delicate these organs are until they begin to fail, and for lack of knowledge boys and girls sometimes sadly abuse their eyes and ears. If your eyes and ears are still good, you will surely be glad to know how to keep them so.

EXERCISE I. STUDIES OF THE EYE

1. **Examining an animal's eye.** If your teacher feels that it can be conveniently done, she will get from a butcher the eye of an ox or of some other animal for your study. By dissection she will give you a chance to see what an eye is made of. What are some of the things you find on the inside of an eye?

2. **Studying an image.** Take a lidless cardboard box that is about an inch each way in size, and in the center of the bottom make a good, clear hole with a darning needle. Cover the open top of the box with tissue paper, fastening the paper to the sides with paste. Take the box into a dark room and hold it so its tissue-paper side is facing you. Two or three inches back of the hole in the bottom hold a burning match or candle, and then observe the image of the flame (upside down) on the tissue paper.

Now enlarge the hole in the cardboard until it is about one fourth of an inch in diameter. Hold the box and the flame as you did before, and see how the image looks this time. If you have a lens of a simple microscope, lay it over the hole in the box, and by shifting the match or

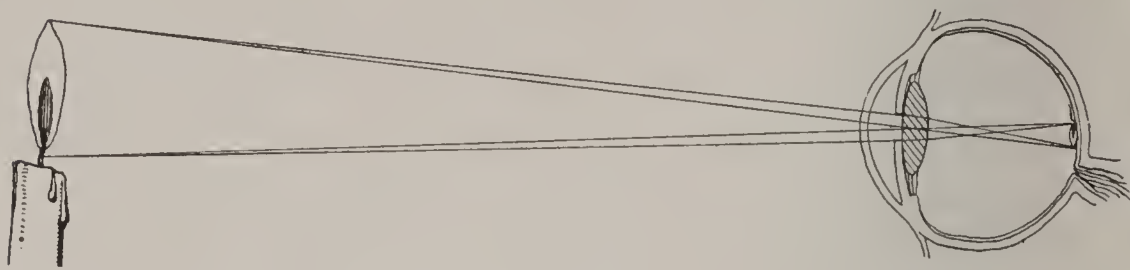


FIG. 29. This diagram of the human eye shows how light rays travel from an object to the retina and form an image there. The image is upside down, of course, but the brain interprets the image correctly.

candle flame toward the lens and away from it, you should succeed in getting a clear image of the flame on the tissue paper again. Now hold the flame somewhat farther off. The image is then like the image that a near-sighted person gets. Hold the flame nearer and you get an image like the image that a far-sighted person ordinarily gets. If in this last case, you put a lens of a pair of glasses for a far-sighted person back of the microscope lens you are already holding back of the hole in the box, you will see why far-sighted people wear glasses. From this experiment what have you learned that explains why people wear glasses?

3. **Effect of light on the pupil of the eye.** While looking at your own eye in a mirror, hold a strong light near one of your eyes and a little to one side of the line between your eye and the mirror. Now move the light a foot or two away from your eye and then back again close to the eye. While doing this, note how the pupil

of the eye changes in size, and remember that it is harder work for the eye to make the pupil small than to make it large. What is the effect of a weak light and what is the effect of a strong light on the size of the pupil of your eye?

4. **The best source for a light in reading.** Try reading a book while a strong light is shining directly on the page and also into your eyes. Now do some reading while the light is at the rear of the head and a little to the left or right of it. Recalling what you learned from Experiment 2, and judging from your own experience, in which case is it harder on the eye to read, with the light in front or with the light to the rear of the head while reading?

5. **The best source for light in writing.** Try writing with a pencil while a strong light comes over the left shoulder, and again when it comes over the right shoulder. It will make a difference, of course, whether you write with your right hand or with your left. When you are writing, should the light for you come over your left shoulder or over your right shoulder, as you find by trial?

6. **Getting cinders out of your eye.** While the hands are very clean, take a small and very clean pencil and seat yourself before a mirror. Now roll the upper lid of one of your eyes over the pencil so that you can see the under surface of the lid. If you had a small particle under your eyelid, some one could now easily remove it with the corner of a clean handkerchief. Have you succeeded in getting your lid turned up without hurting the eyeball?

7. **Testing your eyesight.** The teacher will test your eyesight and that of all the other pupils also, using any ordinary eye chart and following the directions that go

with it. How does your right eye test? Your left eye? Does the test show that you need glasses?

Exercise II. Studies of the Ear

1. **Examining the ear canal.** Adjust yourself so that a strong light shines into the canals of one of your ears. Place a mirror on the side of the head that the light shines on. Hold a hand mirror in front of your eye, so that it faces halfway between the other mirror and your eyes and so that you can see an image of your ear in the hand mirror. You should find that the ear canal leads into the head to the depth of about an inch, and is closed by a membrane called the *drumhead*. Behind this drumhead are the other important organs of hearing. Do you succeed in seeing your drumhead, and is your ear canal reasonably free from wax?

2. **Testing your hearing.** You should have your hearing tested, as well as your eyesight. To test your hearing, you need to sit with your back toward your teacher and twenty feet away, keeping one ear closed. The teacher will now whisper any five letters of the alphabet not in order, which you will write down on paper, one at a time. Test the other ear similarly. Several pupils can be tested in this way at once. If you cannot hear what the teacher whispers, come closer to the teacher until you do hear. If you hear at twenty feet, write 20/20; if at fifteen feet, write 15/20; and so forth. Fifteen twentieths would mean that your hearing is only three fourths as good as most people's hearing.

A. How does your right ear test?

B. How does your left ear test?

Exercise III. Questions on the Foregoing Exercises

1. What has nature provided to protect your eyes?
2. How do you direct your eyeballs sidewise and up and down?
3. Why is it important for you to wear spectacles if your eyes are not as good as they ought to be?
4. Why should you have light that is carefully adjusted, when using your eyes?
5. How can you rest your eyes?
6. Do you have earache often?
7. If foul odor comes from either of your ears, what does this show?
8. Do you have to watch the teacher's mouth closely to understand what she is saying?

Exercise IV. Questions for Investigation

1. Why should you not rub your eyes?
2. How may your eyes become diseased?
3. Find and record in your notebook at least ten rules for preserving your eyesight.
4. How do you hear sound?
5. What is ear wax for?
6. Why should you be very careful about putting anything in your ear canals?
7. What are some good rules you have found for taking care of your hearing?

STUDY FOURTEEN

WHAT TO DO IN ACCIDENT AND EMERGENCY

A VILLAGE of 1149 people would represent an average-sized village in the United States. If all the people of such a village were to die in one year, that would surely be counted a great calamity. Yet the coroner of the city of Chicago reported that in one year, not long ago, exactly that number of people were killed by falling downstairs. Four thousand others were reported crippled in the same way that year in Chicago. Very high-heeled shoes were then in fashion, and that may have caused more than the usual number of people to trip and fall; but always and everywhere a large number of people are being injured in one way or another.

The world is always looking for the boy or girl who

FIG. 30. A class of fifth-grade boys and girls who have been studying how to give aid in cases of accident. They are demonstrating the method of carrying an injured person and also methods of bandaging.

knows how to do things. Nowhere is this more true than in the case of daily accidents. You are now to study how to help others as well as yourself, in case of injury. To do this you will need to have at hand a copy of the *American Red Cross Abridged Textbook on First Aid.*

Exercise I. Bandages

1. **Kinds and materials for making.**

A. Make a drawing in your notebook of a triangular bandage such as is pictured in the book referred to above.

B. Make a drawing of a roller bandage.

C. Make a drawing of a four-tailed bandage.

D. What are three different kinds of textiles out of which bandages are usually made?

E. What are three different purposes for which bandages are used?

2. **Making bandages.** Obtain the material for one sample of each of the three shapes of bandages, and practice making the following varieties of bandages, so that you can give your class and teacher, and perhaps others, a demonstration: *A.* Eye bandage. *B.* Neck bandage. *C.* Jaw bandage. *D.* Head bandage. *E.* Circular bandage. *F.* Reverse bandage. *G.* Figure-eight bandage. *H.* Forehead bandage. *I.* Back-of-head bandage. *J.* Nose bandage. *K.* Chin bandage. *L.* Hand bandage. *M.* Arm-sling bandage.

Exercise II. Treatment of Injuries

1. **Wound dressing.**

A. What materials are needed to make a good dressing for an ordinary wound?

B. How would you dress an ordinary wound on the back of someone's hand?

2. **Treating bloodless injuries.** Show how to give proper treatment in the following cases, using someone to help who will make believe that he has been injured: *A*. Bruises. *B*. Strains. *C*. Sprains. *D*. Dislocation of a finger. *E*. Fracture of the right forearm.

3. **Treating bloody injuries.**

A. How would you treat a wound (*a*) when the blood only oozes out, (*b*) when it flows out steadily, and (*c*) when it pulses out in jets?

B. How would you treat nosebleed?

C. How would you treat dog or cat bites?

Exercise III. Treating Injuries Due to Heat or Cold or Suffocation

1. **Burns.**

A. What is a good general rule (*a*) for preventing fires, and (*b*) for putting out fires?

B. How can you best extinguish fires in clothing that you have on?

C. How should you treat (*a*) a simple burn, (*b*) a blistered burn, and (*c*) a deep burn?

2. **Sunstroke and heat exhaustion.**

A. How can you avoid sunstroke?

B. How should you treat a case (*a*) of sunstroke, and (*b*) of heat exhaustion?

3. **Freezing.**

A. How should you treat a case of frostbite?

B. How should you treat a case of frozen feet or hands?

4. **Suffocation, electric shock, and poisoning.**

A. Give a demonstration of the Prone-Pressure method of artificial respiration in case of suffocation.

B. Give a demonstration of the Sylvester method.

C. How should you treat a case (*a*) of drowning, (*b*) of electric shock, or (*c*) of poisoning?

PART TWO

Community Hygiene

TO THE BOYS AND GIRLS

Till some twenty years ago, sanitary drinking fountains and individual drinking cups were almost unknown in public places. In nearly every school there was an open pail of drinking water, and pupils and teachers all drank from the same tin drinking cups. In those days contagious diseases used to spread rapidly, and particularly among school children. But at Herington, Kansas, something happened in October, 1906, that compelled people to think. Diphtheria had broken out in the town in a very violent form, and a good many schoolboys and schoolgirls were stricken. Five school children were among the first to die. The city board of health and the board of education held a joint meeting to see what they might do. At this meeting Dr. George Klepinger, the city health officer, declared that very definite and strict sanitary measures must be put into operation. Among these measures were the immediate abolishment of the public drinking cup and the installation of sanitary drinking devices at each of the school buildings. Another measure that he recommended was that during the epidemic each child should be examined by a competent physician before being allowed to enter a schoolroom.

These measures were put into effect, and within four weeks every case of diphtheria had disappeared from the town. So well was the board of education pleased with the remarkable success of the abolishment of the public drinking cup that the order prohibiting it was made permanent. Thus Herington, Kansas, was the

first town in the United States absolutely to abolish the use of the common drinking cup in public schools. It is an interesting fact that not another case of diphtheria occurred in Herington for almost five years. That case was immediately quarantined, and no other child caught the disease.

The word "sanitation" comes from the Latin word "sanitas," meaning "health," just as the word "hygiene" comes from the Greek word for "healthful." We, however, use the word "hygiene" with particular reference to that field of health which has to do with our own bodies; and we apply the word "sanitation" to the field of community hygiene. *Sanitation is the science which deals with the problem of making our surroundings healthful.*

STUDY FIFTEEN

BACTERIA, THE SMALLEST OF PLANTS

GERMS are such very small living things that you cannot see them with the naked eye. But if you can get several thousands or millions of them together, they will make a little mass about the size of a pinhead, which you can see very readily. You will not have to have a microscope to study germs in such a mass, but you can learn much more about them with a compound microscope. Some germs are plants and some are animals. The plant germs are called *bacteria* and the animal germs are called *protozoa*.

If you prepare the right sort of place for a single bacterium to grow, in a few hours or a few days there will be so many of them that the colony can easily be seen with the unaided eye. This is because a vigorous, growing bacterium divides into two about every half-hour, and each of the divisions, or new germs, does the same. Your teacher will perhaps make a "germ garden" or *culture medium*, as the doctors call it, in which germs will grow, and then you can learn for yourself many things about bacteria.

EXERCISE I. HOW TO MAKE A GERM GARDEN

Two ways of making a germ garden are here described, the first being the more complex, but also the more satisfactory when done. The second way is simpler, and it does not require any materials not found around an ordinary home.

1. **The agar preparation.** Prepare a half teacup of clear beef broth and add two cups of hot water and one teaspoonful of brown sugar. Do not use dried beef or

FIG. 31. Examining a germ garden. The bottle at the left contains agar preparation, and from it each of the six germ gardens on the table were supplied with culture medium.

bouillon cubes in preparing your broth; and, if you can get it, use grape sugar, or glucose, in preference to the brown sugar. To your preparation add two per cent. by weight of agar, a powdered, gelatinous product of an Oriental seaweed, which is obtainable at the more complete drug stores. Now bring the mixture to a boil, stirring it thoroughly. Filter through a funnel filled with wet absorbent cotton. Collect in a bottle all the material that will strain through, add a little soda and salt, and stopper the bottle loosely with a plug of absorbent cotton. Now set the bottle in a covered metal vessel, and pour

enough water into the vessel to bring the water level up to the neck of the bottle. Bring the whole to boiling for an hour on each of three successive days. This material will solidify on standing and may be kept for some time. When about to use the material, put the bottle in hot water again to melt the contents, and pour a small quantity of it into each of at least twenty thoroughly sterilized test tubes, or other receptacles. Stopper the mouths of the receptacles with plugs of absorbent cotton that have been sterilized by being highly heated in an oven for 15 minutes. Allow the contents of the receptacles to solidify by cooling while the tubes or bottles stand at an angle of about 45 degrees. What, now, is the appearance of your germ garden prepared from agar?

2. **The potato preparation.** The other way to make a germ garden consists in taking a few healthy raw potatoes and cutting from them as many pieces, an inch long and three eighths of an inch square, as there are to be experiments. Take an equal number of test tubes or small bottles, each of which will admit an unbroken piece of potato. Now place all the receptacles in a covered vessel nearly full of hot water, and boil for 3 minutes. Meantime, have at hand some clean, dry, and previously baked absorbent cotton, and, if possible, carry out all directions here without stirring up any dust whatever. Sterilize, by boiling for 15 minutes, a pair of pliers or a wire bent double to serve as a substitute. Lift a test tube or vial from the water with the pliers, put into the tube a piece of potato, add a drop or two of red ink, and insert a loose plug of cotton into the mouth of the tube as a stopper. Now set the tube aside, being careful not to let the water in it touch the cotton. In the same manner drop each remaining piece of potato into a test tube.

Now boil the water in each test tube for one minute, not letting the water boil up against the cotton. This boiling can be done by holding the lower ends of the tubes in a flame, or by lowering the tubes into a teakettle of boiling water.

Set the tubes aside for 12 hours, and then boil each again for a minute. At the end of another 12 hours, boil the tubes once more for a minute. After this last boiling remove the cotton stopper, holding it so that the end that belongs in the test tube will not touch anything. Pour off all the water you can, being careful not to spill the potato, reinsert the cotton stopper, and your culture medium is ready for use. If this has all been done carefully, there should now be no bacteria or mold or yeast in the test tubes. The tubes may be kept for use any number of days later, so long as the potato in them continues to be moist. If test tubes and cotton are not available, use jelly glasses with their lids, and a larger slice of potato. The red ink is used to color the potato and make it easier to see the little white patches of bacteria that should appear in some of the experiments that you are to undertake.

3. **Making the experiments.** The germ-garden vessels should be distributed among the members of the class, giving each pupil one or more experiments to look after. It will take three or four days, under favorable conditions, to develop bacterial colonies sufficiently numerous in germs to show up little white patches on the background of the germ garden. Our purpose is now to find out some places from which germs come and some conditions, both favorable and unfavorable, for their growth.

Exercise II. Where Germs Are Found

1. **Germs from the tongue.** Take a long, thin strip of sheet metal, which must be sterilized by heat each time before it is used, and scrape the tongue with it. (A knife would do very well, but the heat might ruin the temper of the blade.) Carefully remove the germ-garden stopper or lid, transfer some of the scrapings to the surface of the "garden" and promptly replace the cover. Set the vessel aside in a dark place where the temperature ranges from 70° to 90° Fahrenheit. A thermos bottle containing water of the right temperature is an ideal place in which to set your germ-garden vessel. The water in the thermos bottle should not cover the tube. The water in the bottle should be renewed often enough to keep the temperature up. In three or four days report whether small white patches have appeared on the surface of your "garden." What is the result, and what have you learned?

2. **Germs from the teeth.** Do as directed in Experiment 2, only this time use scrapings from the teeth. What is the result and what have you learned?

3. **Germs from the breath.** Do as directed in Experiment 2, but instead of using the tongue scrapings, breathe into the "garden." What is the result, and what have you learned?

4. **Germs from a pencil point.** Do as directed in Experiment 2, but instead of using the tongue scrapings, touch the garden with the point of an old pencil. What is the result and what have you learned?

5. **Germs from pond water.** Take one of the unused germ gardens and put into it a drop of ordinary pond water. Keep for three or four days in any place that is

ordinarily warm and dark. What is the result, and what have you learned?

6. **Germs from fresh milk.** Do as in Experiment 5, but use a drop of fresh milk instead of water. What is the result and what have you learned?

7. **Germs from decayed fruit.** On the germ garden in another tube, place a bit of decayed fruit or vegetable matter, and keep the tube in a place that is moderately warm and dark for three or four days. What is the result and what have you learned?

8. **Germs from dust.** Set an unused garden with its cover off in a dusty room for 10 minutes, and then keep in a moderately warm, dark place for three or four days. What is the result and what have you learned?

9. **Germs from a finger nail.** Put on an unused germ garden some scrapings from under a finger nail, and then keep the tube in a moderately warm, dark place for three or four days. What is the result and what have you learned?

10. **Germs from a drinking cup.** Do as directed in Experiment 10, only this time use scrapings from a common drinking cup, if you can find one anywhere in use. What is the result and what have you learned?

11. **Germs from the skin.** Do as directed in Experiment 10, only use scrapings from the hand. What is the result and what have you learned?

12. **Germs from pus.** Do as directed in Experiment 10, but this time use some pus from a pimple or a sore. What is the result and what have you learned?

13. **Germs from a house fly.** Permit a fly to walk over a garden, allow it to escape, and then replace the stopper. What is the result after several days, and what have you learned?

Exercise III. Favorable and Unfavorable Conditions for Germs

1. **Effect of dryness.** Heat one of the unused germ garden vessels until the garden is quite dry, and then put into it a bit of decayed fruit or vegetable matter. Keep in a moderately warm and dark place for several days. What is the result and what have you learned?

2. **Effect of sunlight.** Put some tongue scrapings on a germ garden and keep the garden three or four days in direct sunlight as much as possible. What is the result and what have you learned?

3. **Effect of low temperature.** Do as directed in Experiment 2, but keep the garden in a cold place, as a refrigerator, for three or four days. What is the result and what have you learned?

4. **Effect of a germicide.** Do as directed in Experiment 2, but add a drop or two of formalin or a 5 per cent. solution of carbolic acid to the garden, just after putting the tongue scrapings on it, and keep in a warm, dark place. What is the result and what have you learned?

5. **Effect of strong acid.** Do as directed in Experiment 2, only this time use any strong acid, other than carbolic acid. What is the result and what have you learned?

Exercise IV. Questions on the Foregoing Exercises

1. What are fifteen different places in which bacteria can ordinarily be found?

2. What are five conditions unfavorable to the growth of bacteria?

3. What are five conditions favorable to the growth of bacteria?

4. Why is each of the following practices bad: (*a*) spitting in public places; (*b*) putting pencils into the mouth; (*c*) moistening the thumb in turning the leaves

of a book; (*d*) licking court-plaster before putting it on a sore; (*e*) kissing little babies; (*f*) scratching a sore with the finger nails; (*g*) drinking from a glass some one else has used?

5. What are three other unhygienic practices?
6. Why should one let sunshine into a sleeping room?
7. Why is it not well to use a feather duster in cleaning a room?
8. Why is it undesirable to permit a fly to walk on prepared foods?

Exercise V. Questions for Investigation

1. What is the difference in the meaning of the words *bacterium* and *bacteria?*
2. Do bacteria belong to the plant kingdom or to the animal kingdom?
3. How big is a bacterium?
4. What are the three different shapes of bacteria?
5. What makes anything decay?
6. Why does the skin carry so many germs?
7. What are some kinds of bacteria that are useful to man?
8. Which kind of bacteria is most numerous: the useful, the useless, or the injurious?
9. How do bacteria live through the winter or through a very dry time?
10. Make a list of health habits that will help to reduce the danger of catching germ diseases.

STUDY SIXTEEN

PROTOZOA, THE SMALLEST OF ANIMALS

We have just been studying the interesting little plant germs known as "bacteria," but there are also many germs that are tiny animals. These germs that are tiny animals are called *protozoa*. If we are talking about only one of them, we call it a *protozoan*. Protozoan germs are usually a little larger than bacterial germs. Several of the *protozoa* are just large enough to be seen with the naked eye, if one's vision is excellent. One of these kinds you are now about to study. These tiny animals are longer than most other protozoans, and they get their name, *paramecia*, from a Greek word meaning "oblong." A single one of them is called a *paramecium*. Paramecia are entirely harmless and are found nearly everywhere in fresh-water ponds and along the shores of streams and lakes.

Exercise I. Getting Protozoa Ready to Study

1. **Developing a crop of paramecia.** As material for these experiments, there will be needed what is called a *hay infusion*, and this should be started by some pupil *ten days or two weeks before* the class takes up the study of *protozoa*. To make the infusion, let the pupil take a good double handful of finely chopped timothy hay or dead grass and put it into a quart Mason jar. Pour warm water into the jar until it is three fourths full. Then put the lid on loosely and set the jar aside in a warm place for ten days or two weeks, or until a white scum begins to form on the water. At first there will be myriads of bacteria; and later, when the white scum comes, numerous little protozoa of the kind called *paramecia* will

FIG. 32. Using two forms of the simple microscope to study protozoa mounted on glass slides. A compound microscope would give a much greater magnification.

develop and feed on the bacteria. If it is possible to get a clam and let it decay in the Mason jar of water, a good supply of paramecia that are larger will develop.

2. **Finding the smallest animals the eye can see.** When ready to take up the study of your paramecia, lay a piece of black cloth or paper on the table, and on this cloth or paper lay a small pane of glass. Now take drops of water carrying some of the scum of the hay infusion, and transfer them to different spots on the plane of glass. Spread out the drops as thinly as possible on the glass, and look for extremely minute and numerous, barely visible, white specks swimming in the water. These are the paramecia. If they cannot be discovered with the naked eye, make use of a simple microscope or magnifying glass. Describe the paramecia that you have seen with the naked eye.

Exercise II. Experiments with Paramecia

1. **Behavior of paramecia.** Study the tiny specks of life until you are able to answer these questions:

A. Do the little animals tend to collect in small groups?

B. Since these creatures give off a weak acid, explain (after completing Experiment 2) why they gather in these groups.

2. **Effect of weak acid.** Put a drop of ordinary vinegar or other acid on a saucer or butter plate and add to it ten drops of water from your infusion. Put the tiniest possible drop of the weakened vinegar into a spread-out drop of water from the top of your infusion, using a needle point to transfer the vinegar. Be careful not to stir the drop of weakened vinegar around any; and let it settle in one single part. What reason have you for supposing that paramecia like weak acid?

3. **Effect of salt.** To another spread-out drop of infusion with plenty of paramecia in it, add the very tiniest grain of salt you can possibly get. Let the salt particle remain in the one spot until it dissolves, and then watch the paramecia around the spot. How do paramecia act toward salt?

4. **Effect of alcohol.** As another experiment, transfer a very tiny drop of denatured alcohol to another drop of water containing many paramecia. What happens to paramecia when alcohol is put on them?

5. **The course of a swimming paramecium.** Clean off your glass thoroughly and spread out on it a good big drop of your infusion water. Use a simple magnifying glass, if you have it; but with or without it, study the way paramecia travel around. Do paramecia travel in straight lines, or in broken, or in curved ones?

6. How paramecia swim. If you have opportunity to examine a mounting of paramecia under a compound microscope, magnifying from 80 to 100 times, you may observe the paramecium's peculiar way of swimming.

A. Does a swimming paramecium keep turning over and over as it swims, and if so, why?

B. Why are some rifle barrels and cannon bored with spiral grooves?

7. Seeing other protozoa. With your compound microscope it may be that you can see other kinds of protozoa, such as are present in the water of a horse trough or in a stagnant pool. If you can find a little protozoan called an *amœba*, you will be fortunate. What other kinds of one-celled animals have you seen?

8. A protozoan in the human mouth. There is a disease of the mouth known as *pyorrhea.* If possible, examine a microscope mounting of matter from the gum around the root of a tooth diseased in this way. The microscope should magnify 300 or 400 diameters. By close observation some of the semi-transparent germs of pyorrhea may be seen to change shape as an amœba does. What is the appearance of a pyorrhea germ?

Exercise III. General Questions

1. How do you think the bacteria and the paramecia ever got into the liquid in which you found them?

2. Since all animals must have air, why do you think the paramecia are more numerous near the top of a hay infusion?

3. Why do you think alcohol affects paramecia as it does?

4. What should you expect to be the effect of alcohol upon the little amœbalike corpuscles in human blood?

5. What are some of the sources in nature where protozoa can be found?

6. Why do we need to know about protozoan germs?

7. What are phosphorescent protozoa?

8. Which kinds of protozoa are more numerous, the harmful or the harmless?

9. What is the most important difference between protozoa and bacteria, as far as you can find out?

10. What are some health habits that would lessen the danger from protozoan disease germs?

STUDY SEVENTEEN

HOW YOUR BODY FIGHTS ITS GERM ENEMIES

The human mechanism has a wonderful way of keeping itself in good working order. Ordinarily a diseased part of the body, *if given a fair chance*, will put itself in good condition again. It is the little cells of which the body is made that do the work of healing and rebuilding. People often talk as if medicines *cure* the body; but the truth is that medicines only help to give the body cells a chance to cure themselves. The body, too, is able to fight disease germs effectively. But when the germs get too numerous, the body must have help if it is to fight them successfully.

Exercise I. The Body's Outer Defenses Against Germs

1. **One purpose of skin on an apple.** Take an apple with unbroken skin and in one spot cut through the skin. Put a drop of ink on the cut and a drop on the unbroken skin. Let the apple stand for a minute or two. Now thinly pare the skin from each of the inked spots and note the condition of the apple beneath. What seems to be one of the uses of the skin of an apple?

2. **Apple skin and germs.** Make an examination of several apples, some of which have decayed spots on them and some of which show no decay. Note whether one group has broken skin and the other not. Can apple skins keep germs out as well as they can keep ink out?

3. **Infecting an apple.** Get a decayed apple and two sound ones. Rub the decayed part of the one apple against a spot on the sound apple where you have cut through the skin with a clean knife. Cut the skin of the

other sound apple with a clean knife, but do not touch the decayed apple to it. Set the two sound apples in a warm place for a week.

A. What have you learned from this experiment?

B. Why should rotting apples be at once taken away from sound ones?

4. **Examining human skin.** Take a clean needle and examine the skin of the back of your hand to see if you can discover a rather thin layer of skin covering the surface of the body. Possibly you may be able to run the needle under this outer layer of skin without pain. How might this skin serve a purpose such as apple skin seems to serve?

5. **The lining of the mouth.** Make a similar examination of the inner lining of the mouth, using a mirror and a very clean needle. How can the lining of the cheek serve a purpose such as the outer skin serves?

6. **How the nostrils serve as a defense against germs.** Face away from a strong light and use a hand mirror in such a way that you can examine the inside of your nose (Fig. 11). The mirror should throw light into the nostrils, as well as reflect their image. You should see that deep in the nostril the inner surface is quite red and carries a slightly sticky moisture. Since the sticky moisture in the nostrils is a good germ destroyer, why should you breathe through the nose?

Exercise II. The Body's Inner Defenses Against Germs

1. **Strong acid as an antiseptic.** Take two apples, each of which has a rotten spot about as big as a quarter. After opening up one of these spots with a knife, pour into it several drops of hydrochloric acid (muriatic

acid) and mix this acid about with the apple decay. Now set the two apples aside for some days.

A. What seems to be the effect of strong acid on germs of decay?

B. What could be one of the uses of hydrochloric acid that is produced in a healthy human stomach?

C. What is an *antiseptic?*

2. **How germs may harm the body.** Once germs get inside the body there are two ways in which the body may suffer harm. Some germs destroy body cells directly, and others make a poison that goes over the body and does harm in many places. In order to defend itself against germs, your body must be prepared both to kill germs and to *neutralize* the poisons that some of them make. In the next few experiments a study will be made of the way your body does these two different kinds of work. To make sure you understand what you have just read, you may write the answer to this question: What are the two different ways in which germs may do harm to the body?

3. **A test for acids.** Put a spoonful of water in a shallow dish. Dip a piece of blue litmus paper into the water and note that it remains blue. Now put a few drops of vinegar, lemon juice, or hydrochloric acid into the water and dip the litmus paper into it again. To what color does an acid change blue litmus paper?

4. **The test for alkalies.** Put a spoonful of water in another saucer and add to it a few drops of ammonia. Test this liquid with pink litmus paper. How can you tell when a liquid is alkaline?

5. **Neutralizing an acid.** Put a drop of ammonia water into the liquid in the shallow dish of Experiment 3, and dip a fresh piece of blue litmus paper into it. Does the

paper change color this time? If so, put a few drops more of ammonia water into the mixture and then dip blue litmus paper into it once more. Repeat, if necessary, until neither red nor blue litmus paper changes color in the mixture. The acid has then been *neutralized* by the ammonia; that is, its effectiveness has been destroyed.

6. The process applied. Put a drop of acid in two different places on a piece of cloth. Now put a drop of ammonia on one of the acid spots and another drop on a third spot in the cloth. Let the cloth lie for a day.

A. What happens to the cloth when it is acted on by acid alone? By acid and ammonia together? By ammonia alone?

B. Why did not the acid make a hole in the cloth when the ammonia was put with it?

7. How a white corpuscle destroys germs. Take some rather fine, dry bread crumbs, color them with red ink, and let them dry again. Besides the crumbs, there will be needed for this experiment a small quantity each of scales of shellac, oil of cloves, and denatured alcohol. Put a part of the scales of shellac in a little bottle and then fill the vial with denatured alcohol. After the shellac has dissolved in the alcohol, pour some of the solution on half of the colored crumbs. Allow the shellacked crumbs to dry, taking care to stir them occasionally so that they do not stick together. You are now ready for an experiment that will illustrate how the white corpuscles of the blood dispose of some of the germs that get into the body.

A. Into a white saucer, pour a teaspoonful of denatured alcohol and 3 teaspoonfuls of water. There should be one dish to every three or four pupils, each group performing the experiment for itself (Fig. 33).

FIG. 33. A drop of oil of cloves, floating on the water and alcohol in the saucer, is enveloping a scale of shellac. The oil of cloves represents a white corpuscle, and the shellac represents a germ. The materials on the table are a bottle of denatured alcohol, a paper can containing shellac, a bottle of oil of cloves, and a beaker of water.

Float a drop of the oil of cloves on the mixture of water and alcohol, and then put a small crumb of the unshellacked red bread close to the drop of the oil of cloves. Does the drop of oil take unshellacked bread into itself?

B. Now put a small crumb of the shellacked bread near the drop of oil of cloves. What does the oil of cloves do when a piece of shellacked bread comes in contact with it?

C. Put another drop of oil of cloves on the liquid and try to "feed" it with a small scale of dry shellac. What does a drop of oil of cloves seem to do when a small scale of shellac is near it? You have seen that a drop of the

oil of cloves will take in a crumb of bread if the bread has shellac on it, otherwise it will not. Remember this.

8. Applying the illustration. Imagine that the bread is a *germ* and that the drop of oil of cloves is a white *blood corpuscle.* Whether a corpuscle takes up a germ depends on whether the blood has in it a substance that acts like the shellac, covering the germ so that it may be taken up. Such a substance which is present in healthy blood, is called *opsonin*, and there is a different variety of it for the germs of each disease. The germ-eating corpuscles in your blood are like spoiled boys, who refuse to eat bread unless this or that kind of jelly is put on it.

Write down the definition your teacher gives you for the word *opsonin.* She may get her definition by simplifying the one she finds in a big dictionary.

9. The source of opsonin in the blood. Just as a boy's mother may refuse to provide jelly except to be eaten on bread, so the body refuses to provide in any large quantity the opsonin that is needed for any particular germ until that kind of germ enters the body. Also, as a mother may refuse to set more jelly on the table before one dishful has been used, so the human body does not renew the supply of opsonin before the present supply has been used up.

Suppose that you have only a little opsonin for pus-forming bacteria in your blood, and that such bacteria get through your skin. The corpuscles will not eat them, because there is not enough of the right opsonin to make the germs "taste good" to the corpuscles. The bacteria then begin to multiply and you have a boil. Meantime, what little of the needed opsonin there may be in your body is being used up by the germs (soaked up in them)

though there is not enough to tempt the corpuscles to begin their eating. Now it so happens that somewhere in the body, though no one knows exactly where, some glands go to work to make the opsonin that is required. When there is a good supply of the opsonin, the corpuscles devour the boil germs, which have grown numerous, and your boil or boils get well. After this you will not be likely to get more boils until the supply of opsonin in your blood runs low again.

A. What gain is there in having boils, if there is any gain?

B. Write the names of two people to whom you have successfully told the story of opsonins in your blood.

Exercise III. Questions on the Foregoing Exercises

1. Why is it important for you to keep your skin from being scratched or torn?
2. When germs get into your mouth along with food, what keeps them from getting at once into your flesh?
3. How do your nostrils help to protect you from germs?
4. What happens to many germs in food, when they get to your stomach?
5. Judging by your experiments with acid and ammonia, how may the body neutralize poisons in the blood?
6. What have you learned from your experiments with oil of cloves, crumbs, and shellac?
7. Make a list of six ways in which the body defends itself against germs.
8. Why do some people catch germ diseases more readily than other people catch them?
9. What can happen in your blood so that after you

have had a catching disease once you may not have it again, at least for a while?

10. What may happen in your blood so that after you have been free from a catching disease for a while you may take it again?

Exercise IV. Questions for Investigation

1. What are germs?
2. What other things do germs do beside produce disease?
3. Are there more disease-producing germs than other kinds of germs?
4. Where do disease germs come from?
5. How do most germs get into the body to produce disease?
6. What are two important rules for preventing germ diseases?
7. In what two ways do germs cause sickness?
8. What is a toxin?
9. What is an antitoxin?
10. How are the commercial antitoxins secured?
11. What is immunity?
12. What is vaccination?
13. How does vaccination for smallpox keep one from having smallpox?
14. How does vaccination for typhoid fever keep one from having the fever?
15. What are some habits you can form to keep your body in a higher state of resistance to germs?

STUDY EIGHTEEN

HOW YOU CAN HELP TO COMBAT GERMS

In stories of warfare carried on by men against their fellow men, the names of generals and rulers are given much space. But in stories of the warfare of mankind against disease, it is the names of great scientists that count. Among the chief heroes of this newer and nobler warfare are Dr. Edward Jenner, who discovered the principle of vaccination, and Louis Pasteur, who invented the treatment for hydrophobia. Among lesser heroes are the persons who have risked their lives for necessary experimentation. What others learned at the cost of years of study or at the cost of life itself, we may demonstrate by simple experiments, while we enjoy the benefits of their discoveries. We should always keep in mind, too, that we are the common soldiers in the army that is fighting to win a complete victory for health over the tyrant Disease.

Exercise I. Experimental Studies

1. Deodorization.

A. Divide a small quantity of some ill-smelling, decaying material into three parts, placing each part in a dessert dish or in a tin lid. Cover the first part with small pieces of charcoal. Cover the second part with pulverized quicklime. Cover the third part with a small amount of chlorid of lime.

After the dishes have stood for an hour or so, use your sense of smell to test for odors. Which deodorizer leaves the least disagreeable odor — charcoal, quicklime, or chlorid of lime?

B. Let the charcoal remain for a day or so on the

decaying stuff used in Experiment A, keeping the material in a warm place. Do you find that the charcoal stops decay; that is, destroys the germs?

2. Fumigation with sulfur dioxid.

A. Secure an ounce of flowers of sulfur. Have at hand for a class experiment a pie pan half full of water. On it float a dessert dish or the lid of a Mason jar. Saturate with kerosene or denatured alcohol a piece of absorbent cotton or cotton batting as big as your thumb and lay it in the center of the dish or can lid. On this cotton pour a teaspoonful of flowers of sulfur and set fire to it. The members of the class should in turn smell the fumes of the burning sulfur, called *sulfur dioxid*. How does sulfur dioxid smell?

B. Put some flies or other harmful insects into a small wire net and hold the net over the fumes of the burning sulfur. What happens to the insects when held over burning sulfur dioxid?

C. Hold several samples of moistened calico or other printed cloth over the fumes of burning sulfur; or hold fresh blossoms over the fumes. How do sulfur fumes affect the colors?

D. Scrape most of the decay out of a decayed spot in an apple. Then hold the apple so that the sulfur fumes will penetrate the remaining part of the decay. Set the apple aside and note whether the decay continues. What is the effect of sulfur fumes on decay in an apple?

3. Fumigation with formalin.

A. When *formaldehyde* is mixed with water it is called *formalin*. As formalin comes from the drug store, it usually contains 40 per cent of formaldehyde and 60 per cent. of water. Take careful note of the appearance and odor of a sample of formalin. If the fumes get into

your eyes they will make them water, but no real harm will come of this. Put some flies or other insects in a small net and hold the net over the fumes of formalin. What happens when insects are held in the fumes of formalin?

B. Hold several samples of moistened calico or else some flowers over the fumes of formalin. Does any change occur in the color of the cloth or flowers when held in formalin fumes? In what respect is formalin a better disinfectant to use than sulfur dioxid?

4. **Disinfection.** You will need for this experiment six apples or other pieces of fruit, each having a small spot of decay on the surface. Scrape out most of the decay. Then in each of the decayed spots put a different disinfectant, properly labeling each piece of fruit. Keep the fruits in a warm place, and after a day or two note the effect of each disinfectant on the decay. The disinfectants to be used are: hydrogen peroxid; quicklime; chlorid of lime; a 5 per cent. solution of carbolic acid; denatured alcohol; a 10 per cent. solution of formalin.

5. **Sterilization.** Recall the usual process of canning fruits and other foods.

A. What kills the germs when fruit is canned?

B. Why does canned fruit sometimes spoil?

C. In your experiments with the germ gardens in Study Fifteen, why did you have to heat all the vessels so hot and so long?

6. **Pasteurization.** You will recall that in your work with the germ gardens, you put a drop of fresh milk on one of your gardens, and that you thus discovered that there are bacteria in fresh milk. Milk does not keep well unless something is done to destroy or reduce the number of bacteria in it. A common method of keeping

FIG. 34. A study of disinfectants. Note on the table the apples in various stages of decay.

down the number of germs in it is Pasteurization. To learn how milk is Pasteurized, you will need two half-pint, or even smaller, bottles of fresh milk. Place one of these for 15 minutes in water that has a temperature of 150° Fahrenheit at the beginning. Then set both bottles in a cold place for 24 hours. Examine the milk in the bottles at the end of that time. Which keeps better, Pasteurized milk or raw milk? Why?

EXERCISE II. GENERAL QUESTIONS

1. What is deodorization? a deodorant?
2. What is fumigation? a fumigant?
3. What is disinfection? a disinfectant?
4. What is sterilization?
5. What is Pasteurization, and after whom was the process named?

6. Why should you be careful about the kind of milk you drink?

7. What are some disease germs that are transmitted through milk?

8. Why should all milk vessels be thoroughly scalded before milk is poured into them?

9. What precautions should be taken in milking?

10. Why is it important that a milch cow be healthy?

11. Who was Lord Lister?

12. What health habits should you have in order that the body may not have to fight so many germs?

STUDY NINETEEN

DISEASES CAUSED BY BACTERIA

In order to make clearer the story of disease bacteria and the way in which they do their deadly work, several teachers and a number of pupils at Columbus, Nebraska, prepared and gave a little play on the subject. The play was a success, and it helped to make the textbook study of the subject much more interesting. No doubt your teacher and your class could do as well in giving the same play or one that you yourselves might devise. The play given at Columbus is set out in Exercise I.

Exercise I. Dramatizing the Story of Contagion

A Battle for Health

Place. An untidy living room.

Characters. Mother, Helen, Elizabeth, Dr. Quack, Darkness, Dirt, First Disease Germ, Second Disease Germ, Third Disease Germ, Dr. Payne, Father, Ned, Sunshine, Fresh Air.

Let each pupil taking part make up to show his character, or else carry a symbol to show it.

Helen lies sick on a cot. Germs hide in corners.

Helen (*coughs*). Mother, my throat is sore.

Mother. Then you had better take your medicine.

Helen. But why must I take that old stuff? It doesn't do me any good.

First Germ. The more patent medicine, the more fun we'll have!

Second Germ. This will be our home for some time.

All Germs. Ha, ha, ha, ha! Now we're full of glee. We are as happy as happy can be.

Mother. I believe Dr. Quack is coming.

Third Germ. Here comes our faithful friend, Dr. Quack.

Enter Dr. Quack

Dr. Quack. Good afternoon. How is my patient getting along?

Mother. Not very well. She has just had another coughing spell. She will need some more medicine.

Dr. Quack. Fine! Hadn't I better leave two bottles this time? Two for $1.49. You can double the dose.

First Germ. Darkness, dirt, disease. We find them in most alleys. But our home will be right here, as long as Dr. Quack is around.

Mother (*looks at bottle*). Why, this is the same kind of medicine you gave me when Helen had the measles. What do you think is the matter with her now?

Dr. Quack. Why, er — well, give her plenty of medicine and she will be all right in a few days. Good day, good day. I'll call again soon. (*Exit.*)

Helen. Mother, he said that the last time he was here, and I am no better. Why can't I have Cousin Jack's doctor?

Mother (*thoughtfully*). I will call Dr. Payne. We have wasted enough time on Dr. Quack. (*Goes out to telephone. Germs get frightened.*)

Darkness. I am beginning to feel that my moments are numbered here.

Dirt. Well, you'll have to go when Dr. Payne comes. We must work harder than ever till he comes, for he will send us away in a hurry.

Third Germ. We can hide and fool him for a while.

Enter Dr. Payne

Dr. Payne. Good afternoon. What have we here? (*Looks at patient, examines pulse, and takes temperature. Looks about room.*) The first thing I must do is to call in my helpers, Sunshine and Fresh Air. (*Goes to door and calls.*)

Darkness. Farewell, comrades, good luck to you. (*Exit.*)

Sunshine. Hurry, for we have much work to do. (*Transforms room. Sweeps out dirt.*)

Mother. Doctor, what is the matter with Helen?

Dr. Payne. Your daughter has scarlet fever, so you will have to be quarantined.

Mother. Oh, surely not! Dr. Smith did not quarantine the Joneses when their children had what Helen has.

Elizabeth. Can daddy and Brother Ned come home?

Mother. Hush, Elizabeth, go and play with your doll.

Dr. Payne. I will phone the city physician and report the case,

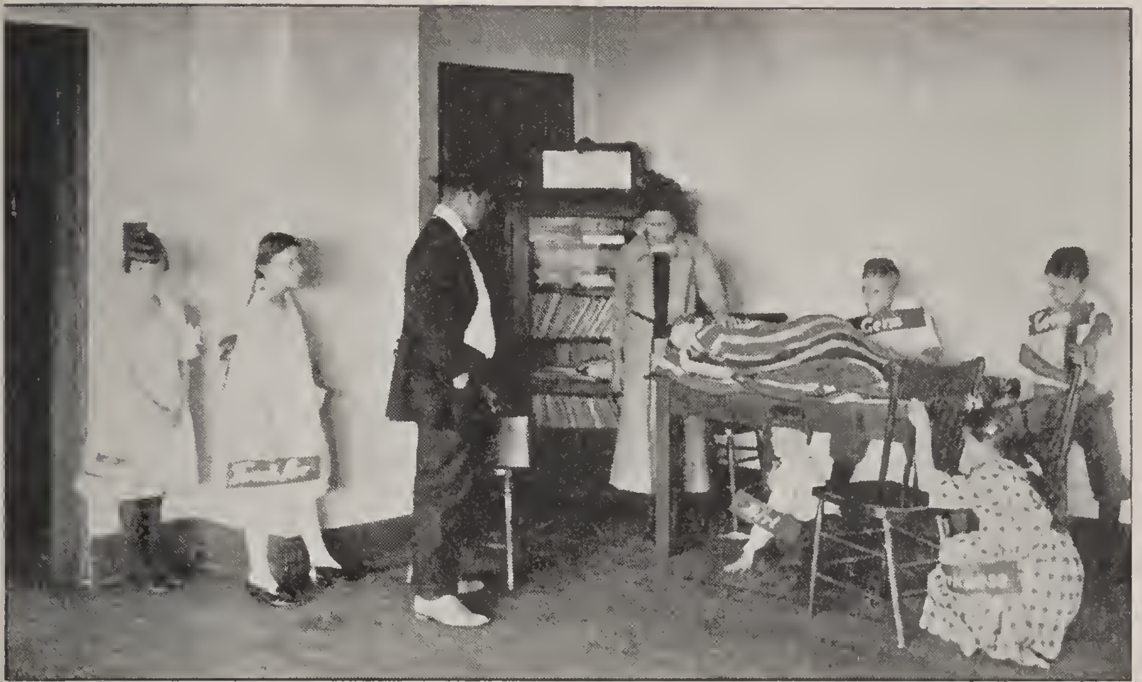


FIG. 35. The visit of Dr. Payne, as one class presented it. The doctor has opened the door to Sunshine and Fresh Air. Germs and Dirt and Darkness must flee.

so he can have the sign put on the house. Where is your telephone?

Mother. Elizabeth, show the doctor the telephone. (*Exit doctor and Elizabeth.*)

Mother. Oh, dear, to think we have to be quarantined for so long!

Enter Dr. Quack

Dr. Quack. Have some more medicine, 99 cents. Finest on the market! Do have some more! (*Pushed out of room by Sunshine and Fresh Air.*)

Enter Dr. Payne

Dr. Payne. I suppose you know it is quite necessary that you obey the quarantine laws.

Mother. What are those laws, anyway? I've never paid much attention to them.

Dr. Payne. Then I must read them to you. (*Reads*) "Whenever a communicable disease that is quarantinable exists in any premises, the entire building is to be placed under quarantine. Smallpox, diphtheria, scarlet fever, and influenza must be

quarantined. Whenever the head of the family desires to be quarantined out and is willing to render to the public as much protection as possible, the person then may be given an antiseptic bath, put on clothing that has been fumigated, and then be turned out." (*While Dr. Payne reads, Elizabeth tips over basket. The mother, in correcting her and picking up the scattered things, pays no attention to the reading of the last part of the law.*)

Dr. Payne. Are you quite sure you understand these laws now?

Mother. Oh, yes! I always did know all of that.

Dr. Payne. Well, I must be going. Be a good girl, Elizabeth, and get plenty of Sunshine and Fresh Air, so you'll not take sick like Helen. I will have this prescription filled for you. Goodby. I shall call again tomorrow. (*Exit.*)

Mother. It does seem a shame that we have to be quarantined. What will father and Ned do for a place to stay? And they must keep working, for we do need the money.

Elizabeth. Oh, here they come now!

Enter father and Ned

Mother. Did you see that horrid sign on the door?

Father. Yes. What does it all mean?

Mother. It means that we must stay quarantined until Helen is entirely well, and that may be a month.

Ned. Well, we can't stay here all of that time. I can't give up my job for the sake of an old card on our house.

Mother. Well, then, what shall we do?

Father. I see no reason why we can't go back and forth. No one will be the wiser if we leave before the neighbors are up, and remain away until dark.

Elizabeth. Oh, no, that wouldn't be right. Miss Smith, at school, says that where there is a red card on your house no one should leave unless he has been fumigated.

Mother. What difference would that make if no one knew?

Ned. Sis is right, mother. If we went back and forth we could carry these germs to some one else, even though we didn't get the scarlet fever ourselves.

Elizabeth. And other little girls might get sick like Helen.

Father. Yes, we must not be the ones to spread this contagious disease any further. That is probably how Helen caught it —

through some one's carelessness and wrongdoing. I'll call Dr. Payne. Perhaps he can tell us something to do. (*Goes out to telephone.*)

Mother. Helen, it is time for you to take some more medicine.

Enter father

Father. Dr. Payne says he will be right down and will fumigate Ned's clothing and mine, and tell us what to do.

First Germ (*frightened*). Fumigate! That means the end of us here.

Second Germ. I am beginning to feel sick already.

Third Germ. Let's stick as long as we can. Don't give up so soon.

Enter Dr. Payne

Dr. Payne. Well, I thought we could fix it it up so you could keep on with your work.

Father. Yes, we must do that, by all means.

Dr. Payne. Now get the clothes you will need and we will go into the kitchen and fumigate them. You had better tell your wife and children goodby, also; for you will not be allowed to come back into this room for a good while. (*Father and Ned get clothes.*)

Father. Goodby, Elizabeth. Be a good girl and mind your mother.

Mother. But what shall we do for the things we'll need?

Father. I will have the milkman leave milk for you and I will also order groceries for you every day. Now don't worry and everything will come out all right. Helen, take your medicine and do what Dr. Payne says, so you will soon be well again. Goodby. (*Exit father, Ned and Dr. Payne.*)

Elizabeth (*running to door*). Goodby, Daddy.

Mother (*weeping*). Oh, dear me! What shall I do?

Elizabeth. Don't cry, mother. Helen will soon be over her illness.

Mother. Well, I suppose I should make the best of it and keep cheerful.

Sunshine. How nice it will be when we get rid of these germs. We can now see our way through. I shall call on my Sunbeams, and this child will soon be well.

Fresh Air. Yes, if people only realized what a help we are to them they would have more respect for us.

Helen. I feel so much better; that fresh air feels so good, and my headache is almost gone.

Mother. Do you, dear? I am so glad, for it will not be long then before we can fumigate the place and have father and Ned come home.

Elizabeth. Oh, goody! Let's fumigate now!!

Exercise II. Questions for Investigation

1. **The pus-forming bacteria.**

A. What are the names of some of the different pus-forming bacteria?

B. What are some of the diseases they cause?

C. How should wounds be cared for?

D. Why are pus-forming bacteria injurious to the body?

E. How can one be protected against pus-forming bacteria?

2. **Tetanus, or lockjaw.**

A. How are tetanus bacteria different from most of the other bacteria?

B. Where are they found in nature?

C. How do they get into the body?

D. Do the germs directly destroy the cells of the body, or do they make a poison that stops the work of the cells?

E. What is a "gas bacillus"?

3. **Diphtheria.**

A. What is the shape of a diphtheria germ?

B. How do diphtheria germs get into the body?

C. Why are they so hard to control?

D. Do diphtheria germs cause injury to the body in the way that tetanus germs do or in the way that pus-forming germs do?

E. Can you prepare a dramatization of the preparation of diphtheria antitoxin?

4. Pneumonia.

A. What parts of the body are affected by pneumonia?

B. What are the two different ways in which the disease may cause death?

C. How do the germs get into the body?

D. How can some forms of pneumonia be prevented?

E. What are the four different kinds of pneumonia germs?

5. Influenza, whooping cough, and colds.

A. What is influenza

B. How can you guard against influenza?

C. What is whooping cough?

D. Why should cases of whooping cough be quarantined?

E. What is the shape of the germs that cause colds?

F. Why should colds be avoided?

G. When you have a cold, what should you do?

6. Tuberculosis.

A. How old is this disease among men?

B. What is the shape of the germ?

C. Who was Dr. Koch?

D. Who was Dr. Trudeau?

E. What is the most common form of tuberculosis?

F. How are the germs transmitted from one person to another?

G. Does the germ do its harm by destroying body cells, or does it do it by making toxins?

H. What animals have tuberculosis?

I. Why should you use milk only from cows that have passed a tuberculin test?

J. How can tuberculosis be prevented?

K. Dramatize the care of a consumptive patient.

7. Typhoid fever.

A. What is the shape of the typhoid-fever germ?

B. How may the germ be transmitted?

C. In what part of the body does the germ do its work?

D. How can the disease be prevented?

8. Some relatives of the typhoid germ.

A. Where does the *colon bacillus* live?

B. What is acute dysentery?

C. What causes diarrhea?

D. What causes summer complaint?

9. Meningitis.

A. Is there only one kind of germ producing this disease?

B. How is infectious meningitis caught?

C. How can it be cured?

10. Some other bacterial diseases.

A. What kind of germ causes sore eyes?

B. What causes acute rheumatism?

C. What kind of germ causes leprosy?

D. What kind of germ causes cholera?

E. What kind of germ causes mumps?

F. Do plants ever have germ diseases?

G. Do lower animals ever have germ diseases?

STUDY TWENTY

DISEASES DUE TO PLANTS OTHER THAN BACTERIA

Some people are troubled with a disease called *hay fever*. Perhaps you wonder why the word "hay" is used to describe the fever. You will have a chance to suggest a better name for this disease after you have found out more about it. It is different from any other disease we have studied so far, for it is one of a group of diseases due to the growth of plants in the body. These plants are of higher form than the one-celled plants we have been studying under the name of *bacteria*. They belong to the group of many-celled plants, a very few of which have the strange life habit of growing, at least in part, in the human body.

Exercise I. Many-Celled Plants That Grow in Part in the Human Body

1. **Examining pollen grains.** Take any freshly blooming plant and note the pollen on the ends of the stamens. Put some of the pollen grains under a compound microscope and study them.

A. Do pollen grains from the stamens of a single flower differ much?

B. Look at the pollen grains from another kind of flower. Are they the same in shape as the pollen grains of the first flower?

C. Now, with your simple microscope, look at the end of the pistil, the little stem in the very middle of the flower. Sometimes there are several pistils, but they always look different from the stamens. The pollen grains fall on the end of a pistil and then grows a little tube down through the pistil where the nucleus of the

FIG. 36. A bad living place for any one susceptible to hay fever. In the foreground is a mass of ragweed headed out and loaded with its trouble-making pollen.

pollen grain helps to make seed. How does the end of the pistil resemble, if at all, the inner surface of the nose?

2. **Finding out about hay fever.** Read about this disease in any recent health book or encyclopedia.

A. What is the cause of hay fever?

B. Where does the disease take hold?

C. Why do hay-fever patients often go to the mountains or lakes in midsummer?

D. What is the new remedy or preventive for hay fever that helps some people?

E. What are some of the plants whose pollen produces hay fever?

F. What could be done so that nobody would have hay fever?

G. What would be a better name than *hay fever* for this disease?

3. **Studying the mold.** Somewhat different are those diseases in which a whole plant grows in the human body, instead of only a part of it as in hay fever. Before you study any plant diseases of this class, you will need to make a little study of that group of *fungous* plants known as *molds*. For your study you will need a slice of raw white potato or fresh bread. This will have to be kept in any rather warm and moist dark place, for a day or two. Numerous fine white threads will now appear. After a little, the mold will turn somewhat darker, as it will develop numerous black seedlike spores. Examine some mold with either a simple or compound microscope. Record here what you have learned. What does a specimen of common mold look like under a microscope?

Exercise II. Questions for Investigation

(Consult Ritchie's *Primer of Sanitation* or a large dictionary or any encyclopedia.)

1. **Ringworm.**

A. What are three different places in which ringworm attacks the human skin?

B. Why has the disease been called *ringworm?*

C. Is this disease contagious?

2. **False tuberculosis.**

A. What kind of plant is *nocardia?*

B. Where does it sometimes grow in the human body?

3. **Tetter, barber's itch, and thrush.**

A. What information about these diseases do you succeed in finding?

4. **Poison ivy.** (This plant does not grow in the body. It is mentioned here because it is responsible for a disagreeable skin poisoning.)

A. What is the cause of ivy poisoning?

B. How can you tell a poison-ivy plant by the leaves?

C. What is the first thing that should be done in a case of ivy poisoning?

5. Concluding studies.

A. Set down in your notebook the names of any other diseases that you may learn are due to plants.

B. What health habits will help to guard against diseases such as those you have been considering?

STUDY TWENTY-ONE

DISEASES CAUSED BY PROTOZOA

In Study Sixteen you learned something about the tiny animals called protozoa. These are the simplest and it is believed that they were the earliest of all animal forms. Just why they should be classed as animals rather than plants is a nice question about which we do not need to bother at this time. Indeed, the scientists have enough to do to distinguish between the simplest forms of life, and sometimes even they cannot definitely classify particular germs as animals or plants. In this Study you are to consider a few of the disease-producing animal germs, or protozoa; and you may, if you choose, dramatize some of the methods of caring for persons afflicted with protozoan diseases.

Exercise I. Diseases Caused by Protozoa

For information study other textbooks, pamphlets, or encyclopedias.

1. **Malarial fever.** After studying carefully Fig. 37, record answers in your notebook to the first nine questions that follow:

A. What is the shape of a malaria microbe?

B. Where does the germ get its nourishment while living in the human body?

C. After the germ has quit its growth in the human body, where must it go next in order to complete its growth, and how does it get there?

D. Into what two distinct forms or shapes do the germs develop in the new host?

E. Form No. 9 is a female germ and forms No. 9*a* and 9*b* are males. What is happening in form No. 10,

and in what part of the mosquito's body does this take place?

F. Where does the resulting form, No. 11, now go?

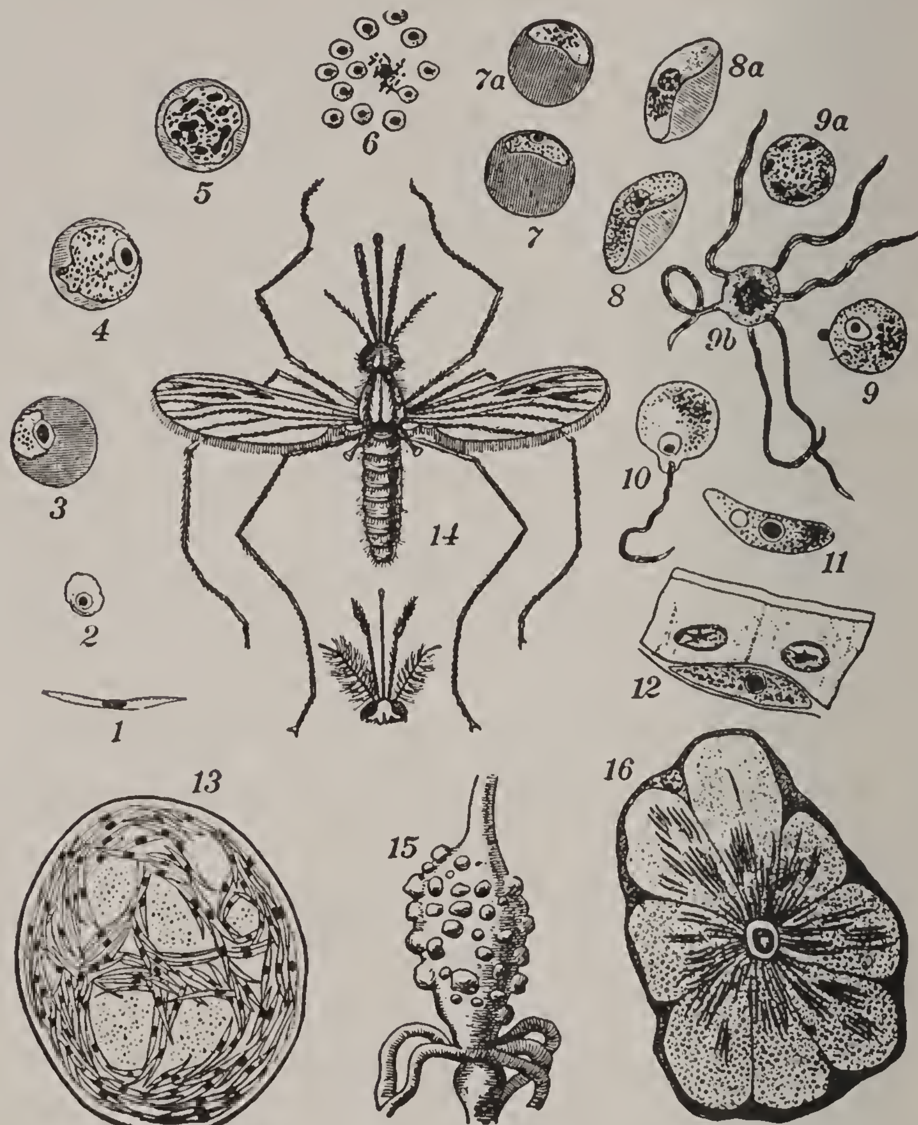


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FIG. 37. The malaria germ and its mosquito carrier. The mosquito could get along very well without the germ, but the germ could not exist if the mosquito were exterminated. Human beings could get along much better without either the mosquito or the germ.

G. Which sex of the mosquito is the one that carries malaria germs to man?

H. How could you keep a human malarial patient from giving malaria germs to some one else?

The answers to the questions immediately following are to be sought for in other books and pamphlets.

I. What did General Gorgas do to show how malarial fever can be controlled?

J. To what parts of the human body does the malaria germ do its damage?

K. What makes one have a chill when suffering with malaria?

L. What medicine is used to prevent and check this disease?

M. In what three ways can malaria fever be prevented?

2. **Yellow fever.**

A. How is yellow fever caught?

B. What did Dr. Walter Reed do to help find out the cause of yellow fever?

C. How may yellow fever be prevented?

3. **Measles.**

A. What is meant by the "incubation period" in a disease?

B. Why should measles be quarantined?

C. Is it really desirable, as people sometimes say, that "boys and girls should have the measles while they are young"?

4. **Smallpox.**

A. What is the cause of smallpox?

B. Has this disease been the cause of many deaths?

C. How is smallpox spread?

D. How does the process of vaccination serve to get more opsonin into the blood?

E. How do you know that vaccination is really valuable?

F. What did Edward Jenner do for humanity?

G. What is your plan for dramatizing the process of vaccination?

5. Rabies, or hydrophobia. (See Farmers' Bulletin No. 149.)

A. To what is hydrophobia due?

B. How could the country be freed from this disease?

C. Why should one avoid being scratched or bitten by a mad dog?

D. Why is the word "hydrophobia" not a good name for this disease?

E. Dramatize the Pasteur treatment for rabies.

6. Other protozoan diseases.

A. What is the difference in the causes of acute and of chronic dysentery?

B. What is chicken pox?

C. What is scarlet fever?

D. What is pyorrhea, or Riggs' disease?

E. What lower animals suffer from the effects of protozoan diseases?

STUDY TWENTY-TWO

DISEASES DUE TO SIMPLE ANIMALS OTHER THAN PROTOZOA

DID you ever hear of measly pork? If you could secure a very thin slice of such pork mounted on a microscopic slide, and could then examine it under even a simple microscope, you would see very tiny wormlike creatures coiled up here and there within it. Measly pork illustrates a case of diseased flesh due to the action of animals of a higher order than the *Protozoa;* that is, many-celled animals.

You will recall that the *Protozoa* are one-celled animals. Most animals are made up of many cells, and these are called *Metazoa*. It has been estimated that the human body is made up of four hundred trillion cells. But there are simple metazoans made up of a comparatively few cells. Some of these make trouble for human beings. What a few of these trouble makers look like, you will find out in the study that follows.

EXERCISE I. QUESTIONS FOR INVESTIGATION

1. **Hookworms.** Examine with a simple microscope preserved specimens of hookworms, if these can be obtained.

A. In your notebook make a picture of a hookworm.

B. Why, do you think, the hookworm was given the name it goes by?

C. How do hookworms get into the body?

D. How does hookworm disease affect the sufferer?

E. In what part of the United States is the hookworm disease most common?

F. In what two ways can hookworm disease be prevented?

2. Trichina. Examine with a simple magnifying glass a mounting of a trichina worm as it lies buried in a thin

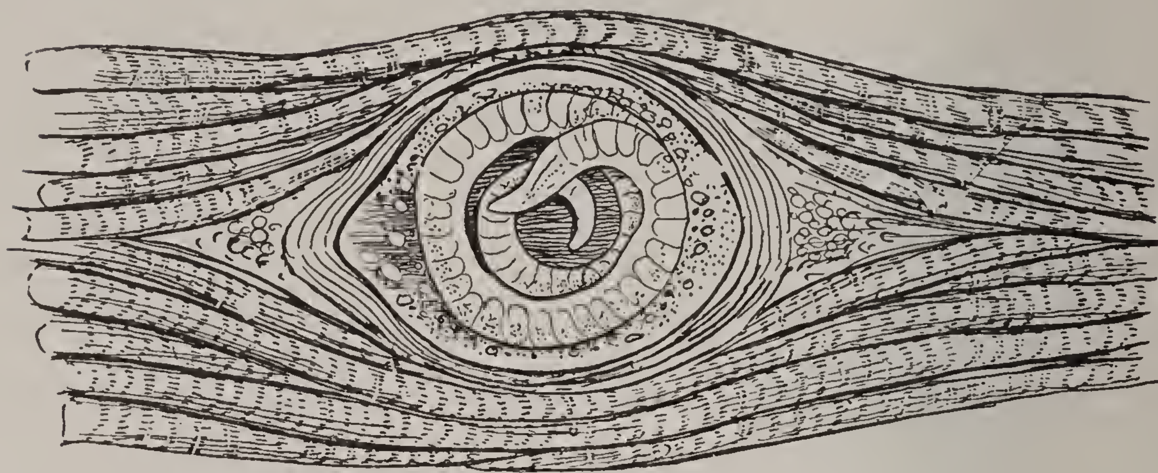

FIG. 38. One of the metazoa (a *metazoön*), greatly magnified. This worm, imbedded in a human muscle, is a *trichina* (tri-ki′na). Trichinæ are most commonly found in swine. At the great packing establishments the pork is inspected for trichinæ as well as for tuberculosis and cholera. Thorough cooking of any meat will kill the ringworms.

slice of pork. If a real specimen cannot be had, be sure to study Figure 38 carefully.

A. Make a little picture of a trichina worm in your notebook.

B. Write briefly in your notebook the life story of a trichina worm.

C. What is the name of the disease caused by trichina worms?

3. Eelworms. From a neighborhood doctor secure, if you can, a bottle containing a few specimens of intestinal worms.

A. In your notebook make a sketch showing the actual size and shape of these worms.

B. What part of the body do eelworms infest?

C. How do eelworms get a start in the human body?

D. What effects do eelworms produce when they once get a start in the human body?

4. **Pinworms.** Examine a few preserved specimens of pinworms, if they can be secured.

A. What is the appearance of a pinworm?

B. In what part of the human body are pinworms sometimes found?

C. How do pinworms get into the body?

5. **Whipworms.** Examine a preserved specimen of whipworm, if you can get one.

A. What is the appearance of a whipworm?

B. In what countries is whipworm disease most common?

6. **Filaria worms.** (See Ritchie's *Primer of Sanitation.*)

A. Copy in your notebook a little picture of a filaria worm.

B. What disease does the filaria worm cause in man?

C. In what countries is this disease common?

D. What insect often carries the germ of this disease to man?

7. What health habits can you suggest to help guard against the various worm diseases?

8. Write in your notebook the names of any other diseases that you may learn are due to simple animals besides Protozoa.

STUDY TWENTY-THREE

MOSQUITOES AS CARRIERS OF GERMS

In former times frightful stories were told and believed about dragons. The dragons were said to infest swamps, from which they would rise to spread death among the people of the land. There was a greater basis of truth for these old stories than one would at first think; but the spreaders of death were the mosquitoes that rose from the swamps. The mosquitoes, carrying the germs of fever, were far more deadly than a monster such as was imagined could have been. A monster might have been fought, but the mosquito was not even known to be the real enemy. Because his ways have not been understood, the mosquito has long been one of the most successful enemies of mankind. You already know of three diseases it carries. Since we now understand the menace of the mosquito, it becomes our problem to get rid of it. In the present Study we shall consider methods of mosquito control. Farmers' Bulletins Nos. 444 and 445 will come in helpfully here.

Exercise I. The Life History of a Mosquito

1. **Two kinds of mosquito wigglers.** Some time in warm weather, when ponds or rain barrels abound with wigglers, provide yourself with a glass of water containing wigglers. Make a study of the different kinds of wigglers to be found in the water. In general, two kinds should be found, a longer sort, the *larvae* (singular, *larva*), and a coiled-up sort, the *pupae* (singular, *pupa*). What are wigglers? Have you found two kinds? Where did you get the water containing them?

2. **Examining mosquito larvae.** Select a number of the

FIG. 39. The members of this class have provided themselves with mosquito "aquariums." The wigglers in these jars will not be allowed to wiggle any more when the study is over.

longer wigglers, the larvae, and put them into a small bottle or test tube of clear water. If the locality is very malarial, it is possible that two kinds of these longer sorts can be found. The larva of the common mosquito (*Culex*) has a bigger head than other mosquitoes, is more lively, and stays under water more to feed; and when it comes to the surface to breathe, it hangs with its head down. The larva of the malaria mosquito (*Anopheles*) has a head only a little larger in diameter than the body, is less active than the larva of the common mosquito, and lies horizontally at the surface most of the time, both to feed and to breathe. What have you learned through observation about the behavior of the common mosquito and perhaps of the malaria mosquito in the larval state?

3. **A larva under a microscope.** Now take a specimen of the larva of the common mosquito and a specimen of the larva of the malaria mosquito, if you have found it. Place each of these in a drop of water on a piece of glass. Study with a simple microscope, looking to find the parts

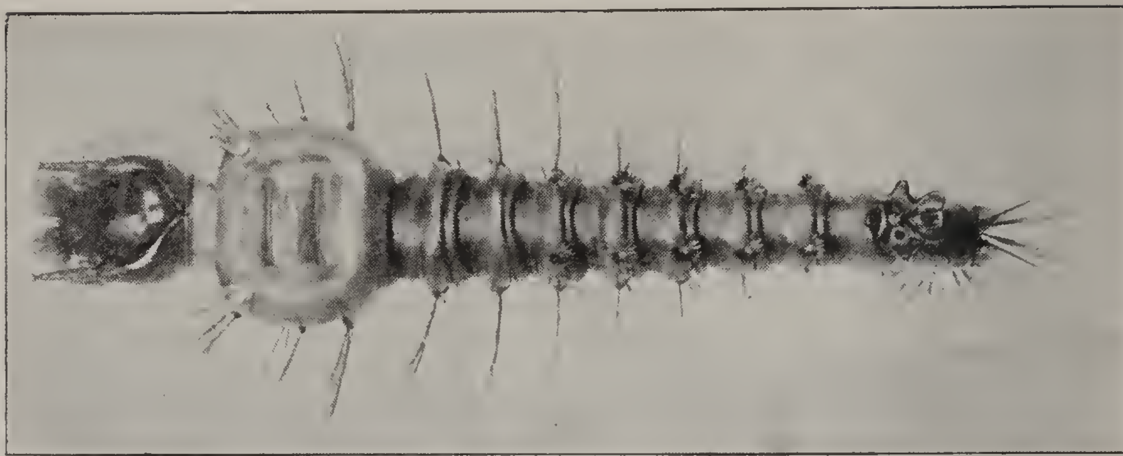

FIG. 40. Wiggler: the larva of the common mosquito. The half-tone cut was made from a photograph of a large glass model of the larva. The model is in the American Museum of Natural History in New York.

shown in the pictures in the Farmers' Bulletins on mosquitoes. Observe especially the differences between the larvae of the common and of the malarial types of mosquitoes. Study Figure 40.

A. In your notebook make a drawing of a mosquito larva.

B. What differences did you find between the larvae of the common and of the malaria mosquito?

4. Examining mosquito pupae. Select from your original supply of wigglers a number of the coiled-up sort, the *pupae*, and put them in a small bottle or test tube of clear water. Again look for the two sorts, common and malaria, the former lying the more nearly vertical and being the more coiled. Experiment with these pupae to find how they behave differently from larvae.

A. In your notebook make a sketch of a mosquito pupa.

B. How do mosquito pupae behave as compared with mosquito larvae? (See Figure 41.)

5. Seeing a pupa under a microscope. Make use of a simple microscope in examining specimens of pupae, just

as you did with the larvae. How do pupae differ from larvae in appearance?

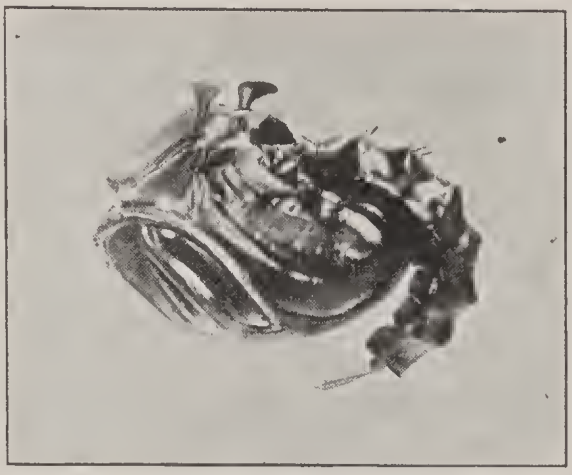

FIG. 41. Wiggler: the pupa of the common mosquito. This illustration also is from a glass model in the American Museum.

6. Capturing an imago. Set in a warm place the glass in which you had your original collection of wigglers and place a piece of glass or mosquito screening over the vessel. Examine the vessel the next day to see if adult mosquitoes, or *imagoes*, have appeared above the surface of the water. How do you know that adult mosquitoes come from mosquito larvae?

7. Destroying baby mosquitoes. Take another vessel with wigglers, and pour into it enough kerosene to make a thin film over the water. Then cover the vessel with a piece of glass or mosquito screening.

A. Do any imagoes appear above the surface of the water after you put kerosene on it?

B. What do you think has happened to the wigglers and why?

C. What is one way to get rid of mosquitoes in a rain barrel or pond?

8. Fish as enemies of baby mosquitoes. Into a third glass of water with wigglers in it, put a goldfish or minnow and see what happens.

A. What reason have you for believing that fish are enemies of mosquitoes?

B. What is another good way to help get rid of mosquitoes?

9. Distinguishing male from female mosquitoes. Examine adult mosquitoes with the naked eye or with the simple microscope to distinguish males from females. The males have feathery hairs, or antennae, between the eyes, and the females have hairs that are not feathery. (See Number 14 in Figure 37.) It is the female Anopheles mosquitoes that carry malaria germs. What difference have you seen between a male and a female mosquito?

10. An imago under a microscope. Study an imago with a simple magnifying glass and find the answers to the questions that follow.

A. How many legs and wings has an adult mosquito?

B. When a mosquito is at rest, on how many legs does it stand?

C. What is the difference in the way a common mosquito and a malaria mosquito stand?

D. How many parts are there to the body of a mosquito?

11. The four stages in the life of a mosquito. To make the life story of the mosquito complete, you have yet to examine a mosquito's eggs. These may be found floating on the surface of quiet water in warm weather. The eggs of a mosquito are no longer than a pin is wide, and only one fifth as wide as they are long. They stick together to make a little raft, if they are from the common mosquito; but they lie alongside each other if they are from the malaria mosquito. What are the four stages in the life history of a mosquito?

12. Raising a brood of mosquitoes. A good way to learn the complete life history of the mosquito is to take one of the egg masses you found and keep it in a glass of water in a warm place, looking at the glass now and then to note the four successive stages of the mosquito's

life. The water in the glass should have a thin scum, on which the eggs float lightly. If kept under water they will "drown," for they are meant to stay on water, much as a needle may be made to float on water.

A. How long does it take to develop mature mosquitoes from eggs?

B. Why do more mosquitoes come from quiet ponds than from wind-blown lakes?

Exercise II. Questions on the Foregoing Exercises

1. Why do wigglers keep coming to the top of the water so often?
2. How does a wiggler get its air?
3. Why did the wigglers die in the water that had oil on top of it?
4. What do wigglers live on?
5. What does the imago live on?
6. What are some ways to get rid of mosquitoes?

Exercise III. Questions for Investigation

1. How do mosquitoes live through the winter?
2. Why should a person sick with malaria or yellow fever be kept screened?
3. What did General Gorgas do to drive malaria fever from the Panama Canal Zone?
4. What sanitary practices do you suggest in dealing with mosquitoes?

STUDY TWENTY-FOUR

FLIES AS CARRIERS OF GERMS

WHAT are the most dangerous animals in the world? Lions? Tigers? Cobras? Tarantulas? No, you have another guess to make. Flies, flies, flies! These are the most dangerous animals in the world, for they are carriers of more disease germs than are any other creatures. In addition to being so dangerous to health, flies are a nuisance in many ways. You should learn all you can about them so you can help the more effectively to get rid of them. Farmers' Bulletins Nos. 734, 851, and 1097 will give you a great deal of information.

EXERCISE I. STUDYING THE ADULT HOUSE FLY

1. **The upper side of a fly.** Catch a house fly and kill it with a drop of gasoline. Mount it on a small white card

FIG. 42. Louis Agassiz, the great naturalist, used to tell his students over and over again, "Study your fish!" When all had studied their fish, Agassiz would teach them what they had been unable to learn for themselves. The students shown here are beginning a study of the fly in the right way, by examining specimens mounted on white paper.

by running a pin through the thick part of its body. Using the pin as a handle, make an examination of the fly's upper parts with the naked eye and also with a simple microscope. Note the shape of the head, the big compound eyes, and the narrow neck. Look for the featherlike hairs between the eyes. Count the black stripes on the back of the fly, for no other kinds of flies are marked exactly as the house fly is. See if there are hairs on the back also. Look for the marks of veins on the wings and especially the veins at the rear, next to the inside, and in each wing note the knee-shaped bend of this vein. Only house flies have these veins bent so. Pull the wings off and see the little knob-ended balancers just back of the place where the big wings are fastened to the body. These balancers are all that are left of a second pair of wings that flies had, long, long ago. What are five or more facts you have found out by studying the upper side of a house fly?

2. **The underside of a fly.** Mount another specimen of a house fly, pinning it back-down to the card. Note that the body is made up of three main parts, the head, the thorax, and the abdomen. With a simple microscope observe the *proboscis* of the fly, and the parts of the face. With a very strong magnifying glass, look at the feet, noting the fine hairs that have some sticky stuff on them.

A. Do you think the house fly bites, or does it merely suck its food with its proboscis?

B. Are there hairs around the mouth?

C. How many pairs of legs has a fly? Any insect?

D. To which part of the body are the legs fastened?

E. Are there hairs at the back of the hindmost pair of legs? If so, then you may be sure you are studying a house fly, for other flies do not have these hairs.

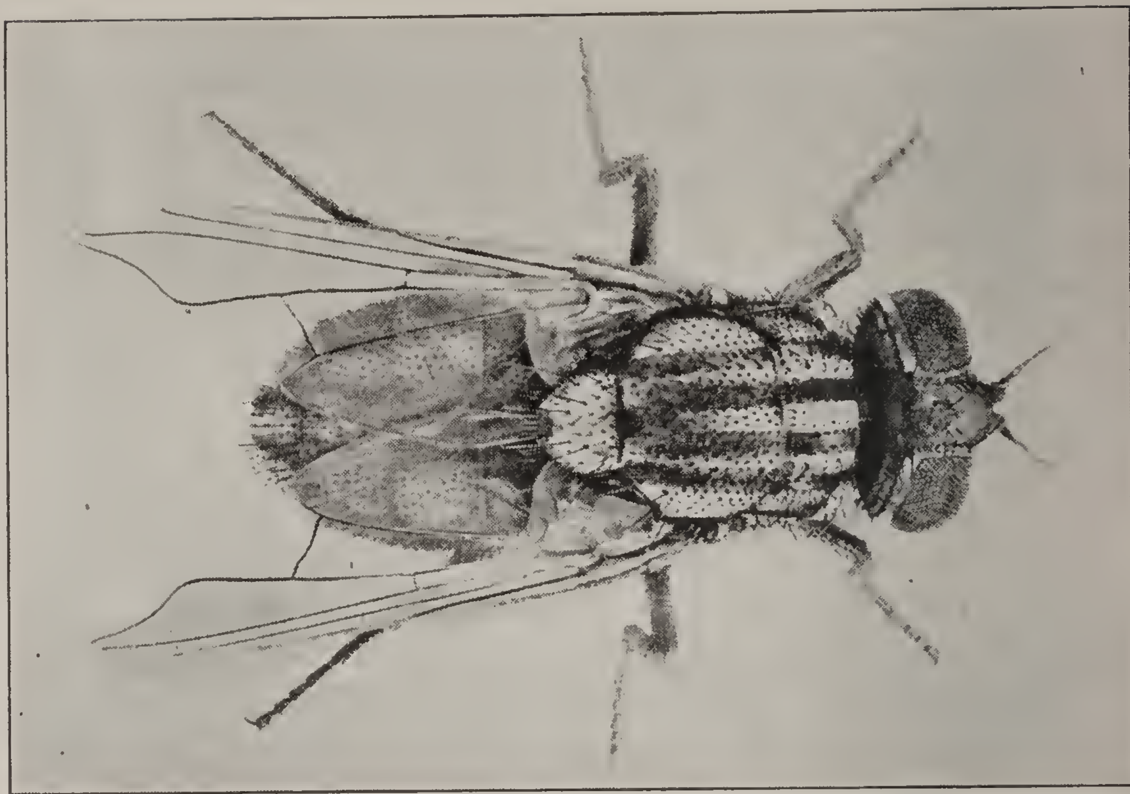

FIG. 43. The common house fly. This cut also is made from a photograph of a very large model in the American Museum of Natural History.

F. On what part of the abdomen do you find hairs?

G. How are flies able to walk on walls and ceilings; as you judge from examining their feet?

3. **Various kinds of flies.** Examine a few other kinds of flies, if you can get specimens, such as the stable fly, blowfly, horse fly, and botfly, and see how each differs in appearance from a house fly. Particularly, make a close examination of a stable fly's mouth.

A. Does a stable fly bite or does it suck its food?

B. When a fly bites you, can it be a house fly?

C. How does a blowfly, either blue or green, differ from a house fly?

D. How does a horse fly differ from a house fly?

E. How does a botfly differ from a house fly?

4. **The behavior of flies.** Collect a few flies in a small screen flytrap and study their movements for a while.

A. Why does a fly rub its feet together every now and then?

B. Which way does a fly do the most walking on the side of the trap, up or down?

C. Why is a flytrap usually made to let the flies in at the bottom instead of at the top?

D. If you make one side of the trap dark and the other side not so dark, on which side do you find the flies collecting?

E. If you make one side of the trap very bright and the other not so bright, on which side do the flies prefer to collect?

F. Judging from your experiments, what degree of light do flies prefer?

G. Why do you think flies in a darkened room seek streaks of light at the windows?

H. By what sense (sight, hearing, or smell) do flies find food, as you judge from putting a thin cloth on one side of a fly cage and then bringing food near that side of the cage?

5. **Flies as germ carriers.** After recalling the experiment in which you caused a fly to walk over a germ garden, what do you know of a fly's ability to carry germs?

Exercise II. The Life Story of a Fly

1. **The egg stage.** Do you think gnats are only baby flies, or do you think flies develop from something else than gnats? You can find out for yourself. Put a piece of fresh meat out of doors for blowflies until a deposit of the flies' eggs is found on it. In the bottom of a drinking glass put a piece of moist cloth. Fill the glass

two thirds full of bran or breakfast food, and place the piece of fly-blown meat on the bran or breakfast food. After covering the glass with fly screening, set it aside in a warm place.

The egg stage is, of course, the first stage in the life history of a fly. Carefully examine a fly's egg with a simple microscope. What have you learned about the appearance of the egg of a fly?

2. **The larval stage.** The second stage of a fly's life comes after about a day, when the eggs are hatched out. This is the maggot, or larval stage, and it lasts about a week. Examine the development of the maggots from day to day, being careful to keep the cloth in the bottom of the glass moist. How many times is the grown maggot larger than the egg?

A. Just how many days was it until your larvae, or maggots, quit eating and began to go into the next stage?

3. **The pupal stage.** After the maggots are full-grown, they will pass to the bottom of the glass to enter their third or pupal stage. They are now called *pupae* (singular, *pupa*) and look like small, imperfect grains of wheat. They will remain seemingly quiet for nearly another week. Supplement the study of this stage, if you can, by digging into the bottom of a pile of horse manure and finding there a quantity of pupae.

A. What is a pupa?

B. Of what color is a pupa?

C. Will a pupa move if you touch it?

D. Where are most house flies hatched?

E. What would be one good way to reduce the number of flies in a neighborhood?

4. **The imago stage.** If all has gone well, the adult fly or imago should appear in your breeding glass after

about a week of the larval stage. Be very careful to keep the screen on the glass at this time.

A. Just how long did your flies continue in the pupal stage?

B. How does the size of the body of an imago compare with that of a full-grown maggot?

C. What are the four stages in the life history of a fly?

D. How long altogether did it take your flies to develop?

Exercise III. Getting People Interested in a Fly-Free Community

For about fifty cents there can be had of the International Harvester Company, Chicago, Illinois, a set of fourteen stencils for making fly charts. These stencil sheets, which are about 30 by 45 inches in size, give a lot of information about flies. With these in hand, the outlines of charts can be made on suitable paper; but the stencil marks will need to be touched up with colored pencils. The chart making may well be divided up among the members of the hygiene class.

When the charts are all completed, they should be mounted on a stand or hung against the wall. Then on some Friday afternoon you and the other pupils may give talks on flies to school visitors whom the teacher and you have invited. Let each pupil select one of the charts and with it make a four-minute talk. The teacher will be able to provide each pupil with one or more pamphlets about flies, from which his little speech can be made up. Indeed, you can find speeches already prepared in the little book the International Harvester Company sends out with the stencils. By putting on a good program, which may well contain exercises besides those on flies,

you can help to make your community better informed on the fly question and thus better able to guard its health.

1. What have you done to help establish a fly-free community?

2. What reason have you for thinking you have had some success?

Exercise IV. Questions for Investigation

1 Are flies ever really useful?

2. How do flies differ from other insects in the number of their wings?

3. In what two very different ways may flies carry germs?

4. About how many germs does an average fly carry on its body?

5. Why is it not well to have flies alighting on the food you eat?

6. For what two reasons is it not wise to have flies around a sick person?

7. Why should houses be screened in summer?

8. How can a flytrap be rigged up in a stable window so as to clear the stable of flies?

9. What is really the most effective way to get rid of flies in a neighborhood?

10. What are four practical ways to get rid of adult flies about your own house?

11. Why is typhoid fever more common in the country than in the city?

12. What germs besides those of typhoid fever may flies carry?

13. What are some good rules of sanitation regarding flies?

STUDY TWENTY-FIVE

QUADRUPEDS AS DISEASE CARRIERS

Somebody has calculated that there is a rat for every man, woman, and child in the world. Think how much waste of food, destruction of property, and transmission of diseases is due to vermin such as these! Next in importance to the campaign for ridding a neighborhood of flies comes that for ridding it of rats. Other germ carriers among quadrupeds are but little less important to know about and to control. Farmers' Bulletins 740, 754, 781, 896, 897, and 1069 will supply valuable information concerning some of these. See also "The Rat, a Sanitary Menace," a pamphlet issued by the United States Health Service; and "The Domestic Cat," Eco-

Fig. 44. This dog and her puppies are friendly enough, but they may assist in the spread of disease. If you have a pet dog, you should keep it clean and free from vermin; and at times it may be your duty to keep it muzzled.

nomic Bulletin No. 2, issued by the State Board of Agriculture, Boston, Massachusetts.

Exercise I. Dogs and Cats

1. **Dogs as disease carriers.** From what you know of dogs, answer the questions that follow.

A. How may dogs become carriers of disease?

B. What insects may dogs carry?

C. Of what use, if any, are dogs around a house?

D. Of what use around a farm? In town?

E. If dogs are to be kept, what precautions should be taken to prevent them from becoming a health menace?

2. **Cats as disease carriers.** From what you know of cats or can learn from the Economic Bulletin referred to above, answer the questions that follow.

A. What habits of cats make them possible carriers of disease germs?

B. If a cat is a really useful animal, what are some of its uses?

C. If a cat is to be kept as a pet, what care should be taken to prevent it from becoming a disease carrier?

D. Why should you not allow a cat to lick a sore?

Exercise II. Rats and Mice

1. **Rats as disease carriers.** From what you know of rats, and from the U. S. Health Service pamphlets referred to above, record answers to the questions that follow:

A. What is the food of a rat?

B. What habits of rats make them particularly undesirable about a dwelling house?

C. How can rats become carriers of disease?

D. What are some disease germs that rats carry?

FIG. 45. These fine-looking Jersey cattle seemed to be healthy, but the tuberculin test showed that most of them were affected with tuberculosis. The national government and our state governments are doing a great deal to protect people from diseased meat and infected milk.

E. How can a place be freed from the rat pest?

2. **A mouse.** If your teacher thinks it well to do so, you may make some simple studies of a live mouse in a cage. However, perhaps you already know enough about the habits of a mouse to be able to answer the questions that follow

A. What do mice eat?

B. How can they be carriers of disease?

C. What are some disease germs they may carry?

D. What reasons are there for ridding a house of mice?

E. How can a home best be freed of mice?

EXERCISE III. CATTLE AND HOGS

1. **Cattle as disease carriers.** For studying cattle as disease carriers, you should have at hand Farmers' Bulletin No. 1059, and you should also have the bulletins issued by your state veterinarian, who may be addressed at your state capital.

A. What common disease does a cow sometimes give to people?

B. How has it been made possible for you to be sure, in some of our states, that the milk you drink does not contain the germs of this disease?

C. What do you think of a man who will sell the milk or the meat of a cow that he knows is diseased?

D. In your state whose business is it to find out whether a dairyman's cattle are diseased?

2. **Hogs as disease carriers.** Either in city or country much can be learned from a visit to a slaughterhouse. If you make such an excursion, you should note particularly whether the meat is handled in such a way as to guarantee that it is wholesome when it is placed on sale in the meat markets.

A. What feeding habits of hogs make them easily capable of catching disease?

B. What are two diseases that hogs are particularly liable to transmit to human beings?

C. To what extent is a hog raiser under moral obligation to see to it that his hogs are free from disease?

Exercise IV. Questions for Investigation

1. What disease do dogs sometimes give to people?
2. Are dogs more beneficial than injurious?
3. Why should you not fondle a sick cat?
4. What should be done with a cat that kills birds?
5. Does a domestic cat do more harm than good?
6. How much do rats cost America every year?
7. What disease do fleas help rats to give to man?
8. What is the work of a veterinarian?
9. How can he be helpful in maintaining good health in a community?

10. How much money is lost every year in America because the cattle herds have not been freed from tuberculosis?

11. How do cattle catch tuberculosis?

12. What is the tuberculin test for cattle?

13. What is tuberculin and how is it made?

14. When a cow has been given an injection of tuberculin, how can you tell whether she has tuberculosis?

15. What is an "accredited" herd of cattle?

16. How do hogs catch tuberculosis?

17. What is the tuberculin test for diseased hogs?

18. What provision has the Government made for the inspection of meats?

19. What disease germ does the tsetse fly carry?

20. What disease germ does the tick sometimes carry?

21. List ten diseases that human beings sometimes transmit to human beings.

22. What is a "typhoid carrier" among men and women?

23. What rules of sanitation should be observed to guard against infection from the animals you have studied?

STUDY TWENTY-SIX

DISPOSAL OF GARBAGE, RUBBISH, AND WASTE

In the city of Topeka, some years ago, there was a campaign to clean up the streets, alleys, and lots of the city in order to promote health and comfort and to better the appearance of the place. Mr. A. J. McAllister, who was then principal of one of the ward schools of Topeka, hit upon the idea of having his boys given a commission from the health officer to assist in the campaign. He divided his ward into smaller districts and had groups of boys coöperate with the people in cleaning up their premises. The boys courteously suggested to the householders the need, if any, for improving the appearance of their surroundings and offered to help in the work, either for pay or not, as the case seemed to justify. A vigorous clean-up contest was developed among the various wards of the city, with the result that the ward which the boys looked after showed the largest improvement in the whole city. The leading Topeka paper, you may be sure, had much to say about the achievement of the sanitary squad of that ward school.

Exercise I. Disposal of Rubbish

The term "rubbish" is here applied to useless materials that decay rather slowly, or not at all, as ashes, cinders, tin cans, and fragments of old building materials. Since rubbish, in addition to being unsightly, will harbor vermin, its disposal becomes a matter of vital community concern.

The following questions are to be used in a survey you are to make around your own home.

FIG. 46. A picture was taken of Mr. McAllister's "Sanitary Squad," but the only copy of it proved unfit for reproduction. So a group of boys in the same school posed here to represent the original squad. These boys are worthy successors, it is to be hoped, of Mr. McAllister's boys.

1. What kinds of materials make up most of the rubbish around your home?
2. Is all or part of it regularly thrown into an alley or somewhere else off the premises?
3. Is most of the rubbish thrown freely around on the ground near the house?
4. If thrown about in this way, is there a regular time for cleaning it up say once a year?
5. Is the rubbish ordinarily thrown in a careless heap that will harbor vermin?
6. Is the rubbish kept in boxes, barrels, or other containers, making the place look neater, but still providing a haunt for rats?
7. Is the rubbish kept regularly in a neat, rat-proof place?
8. By whom and at whose expense is the rubbish removed? Can some of it be sold as junk?
9. What is done with it when it is removed?

Exercise II. Disposal of Garbage

Garbage is understood to be the kitchen waste material that is likely to decay rapidly. The word is here meant to include dishwater and other kitchen waters, and the waste material left from preparing meals, as well as that left after meals.

1. Is the garbage at your home, or most of it, thrown freely about the place?
2. Is all or a large part of it kept in barrels or garbage cans, to be fed to hogs or other animals?
3. If a swill barrel or garbage can is used, is it well covered so as to keep out flies and other insects?
4. If the garbage container is well covered, is there a large flytrap kept set near it?
5. If the water is drawn off from the rest of the kitchen refuse, what is done with this residue?
6. Does this residue serve to help breed flies?
7. Is the residue from the garbage dried and then thrown away?
8. Is it burned in a stove, or in a furnace, or in a regular *incinerator?*
9. Is it buried and well covered with soil?
10. Is it fed to chickens or to pigs?
11. Is it set out to be collected by a garbage man?

Exercise III. Disposal of Waste

Pamphlets dealing with the subject of waste disposal are to be had of the United States Health Service and the United States Department of Agriculture, Washington, D. C.

1. Is there an inside toilet in the house where you live?
2. If so, is it connected with a general city sewage and water system?

3. If thus connected, how is the sewage disposed of finally?

4. If not thus connected, in which of the following ways is it treated:

A. By distribution to a running stream?

B. By surface distribution?

C. By subsurface distribution?

D. By a septic-tank system?

E. If an outhouse is used, is it over an unprotected pit?

F. Is the outhouse provided with a protected but removable can or box?

G. If a box is used, are the contents frequently buried?

H. Is the outhouse stocked with dry earth or slacked lime for covering purposes?

I. Is the outhouse equipped with a septic-tank device?

J. Is some other good device used?

Exercise IV. General Questions

1. What is the best way to take care of rubbish about any home?

2. What is the best way to take care of garbage about any home?

3. Why should there be the greatest of care in disposing of human wastes in a sanitary way? How is hookworm disease spread?

STUDY TWENTY-SEVEN

GOOD WATER FOR DRINKING

"Water, water, everywhere,
Nor any drop to drink."

THIS is the cry of the Ancient Mariner in Coleridge's poem; and in all old tales of the sea, the problem of getting and keeping a supply of drinking water figures prominently. At first thought it seems curious that seagoing vessels should have to carry a supply of water with them. But the drinking of sea water, when no fresh water is to be had, brings madness first and then death. Sea water, however, is not the only water that is unfit to drink. Sometimes the clearest-looking fresh water is deadly, for it may carry the germs of typhoid fever or germs of other diseases, as dysentery. In this Study we shall consider methods of getting wholesome water and keeping it fit for human use.

EXERCISE I. EXPERIMENTAL STUDIES OF WATER

1. **Vaporization and boiling point.** Pour a pint of water into a large tin can that can be securely stoppered, and place the can over a burner. Heat till the water boils and the can is filled with steam. Determine the temperature of the steam by lowering a dairy thermometer into the can. Take the can from the source of heat, stopper it quickly and tightly, and then sprinkle cold water over the outside of the can, to cool the steam within. Ordinarily the can will collapse with weird contortions, owing to the removal from the inside of the pressure that balances the natural pressure of the air on the outside.

A. What is the temperature of boiling water and steam at the altitude where you live?

FIG. 47. An experiment in vaporization. These boys boiled a pint of water in the big oil can, and then fastened the screw-cap stopper. They have just sprinkled the steam-filled can with cold water. See what has happened to the can!

B. Would this temperature be higher or lower if you were to try this experiment at a higher altitude?

C. What crushed the can down when you poured the cold water on it?

2. Freezing point of water. The freezing point of water may be found by taking the temperature of water that has plenty of ice floating in it. If possible, a bucket of dirty water should be put where it will freeze over. Later,

the ice can be taken off and some of it melted and poured into a clear glass to see if there is any sediment deposited.

A. What is the freezing temperature of water?

B. Is the water in ice water as cold as the ice itself?

C. When water is changed to ice, what seems to be the effect on its clearness?

3. **The solvent power of water.** Take two glasses of clear rain water and dissolve a teaspoonful of salt in one of them. Now fill a third glass with water from one of the wells in the neighborhood. Allow all three glasses to stand in a warm place until their contents dry up.

A. Was the salt destroyed by being dissolved in your glass of water?

B. Did you get back practically all the salt you put into the glass?

C. How do you know that your sample of well water had some substance dissolved in it?

D. Why can you not tell by merely looking at water whether it is good water to drink?

4. **Power to absorb gases.** Fill one jelly glass with clear water that has been exposed to the air for some time, and fill another glass with water that has just been boiled. Into each glass put a bright nail and cover the glass with a lid. Examine both nails the next day, remembering that iron will not rust unless there is some of that part of the air known as oxygen present along with moisture.

A. What is shown by the difference in the appearance of the two nails in your experiment as to the amount of oxygen in each glass?

B. What accounts for most of the difference in taste between water previously boiled and water not boiled?

C. Why do fishes in an aquarium stay close to the top of the water, if the water has not recently been changed?

5. **Hard water and soft water.** Prepare a soap solution by dissolving a small piece of soap in a bottle of hot rain water. Provide half a bottle of hard water and half a bottle of soft water, put a small quantity of the soap solution into each, and shake both thoroughly. Compare the contents of the bottles after the shaking.

A. What do you think makes water hard?

B. Why is cistern water soft?

C. Why is soft water more desirable than hard water for washing purposes?

6. **Filtration of water.** Secure a number of samples of neighborhood drinking water. Strain the different samples through a funnel, putting a fresh filter paper or piece of absorbent cotton in the bottom of the funnel before each straining.

In each case, is there any substance remaining on the filter paper or cotton?

A good demonstration of the filtering power of soils can be made by taking several ordinary flower pots of quart capacity and filling them respectively with garden soil, fine sand, coarse sand, and gravels both fine and coarse, then pouring a pint of very muddy water into each filter and collecting in a drinking glass the water that leaks from each pot.

A. Which kind of soil, garden soil, fine sand, coarse sand, fine gravel, or coarse gravel, lets through the least dirty water?

B. What kind of soil lets through the dirtiest water?

C. Is any of the water that you filtered entirely pure?

D. How could you find out whether your filtered water has germs in it?

E. If germs are present, how can the water be freed from them?

Exercise II. A Survey of Water Supplies

Dr. B. C. Hendricks, of the University of Nebraska, has prepared the following studies of water-supply sources. You are expected to answer these questions that apply to the kind of water supply you have at home.

1. A well survey.

A. Depth and diameter of well?

B. Was the well dug, drilled, or driven?

C. If dug, is it properly walled?

D. What is usually the depth of water in the well?

E. What seems to be the source of the water?

F. Is the water hard or soft?

G. Is the water clear, odorless, and tasteless?

H. How long is it since the well was cleaned or examined?

I. How is water drawn from the well?

J. Is the well so covered as to keep out all surface water and waste?

K. Is the well perfectly rat-proof?

L. Is there any danger of infection by water from house or outhouse drainage?

2. A cistern survey.

A. What is the capacity of your cistern?

B. Is your cistern lined with concrete, or brick, or both?

C. Does the cistern leak?

D. For what purpose is the water used?

E. Is the water clear, odorless, and tasteless?

F. Is the cistern covered so as to keep out everything but rain water and air?

G. What kind of filter is used, or is none used?

H. Does the filter really do its work well?

I. How is water drawn from the cistern?

J. How frequently is the cistern thoroughly cleaned?

K. What is the character of the roof from which the water for the cistern is collected?

L. Are the eaves-troughs and conduits in good condition?

M. At what time of year is the cistern generally filled up?

N. Is any care taken to have the roof fairly clean when water is allowed to go into the cistern?

O. How is water from the roof taken care of when it is not entering the cistern?

3. **Central water supply for a community.** If there is a pumping station and community reservoir, standpipe, or water tower, from which water is obtained for your home, make a study of the source and treatment of the water before it gets to your house. If the source is in wells, the study of wells provided above can be modified to fit the case. The report on the place of water storage is important in such a survey. Describe the source, storage, and care of the water that comes to your home if it is not taken from well or cistern.

A. By what system is water supplied to your community?

B. What reasons have you for thinking it is pure, or impure, as the case may be?

STUDY TWENTY-EIGHT

COMMUNITY CARE OF THE SICK

You may have seen tacked up on some house in flaming color a card which read like this: "Quarantine. Scarlet fever. All persons are prohibited entering or leaving these premises under penalty of fine or imprisonment." Perhaps you have wondered who put this card up, what right he had to do so, and whose business it may be, anyway, whether or not a family has scarlet fever. These and other questions very naturally come up and they require answer.

Exercise I. Boards of Public Health

1. **Health boards in your state.** Secure from the chief health officer of your locality copies of the rules and regulations of the state and local departments of health. Find out from these how the local and state boards of health are organized; and from any source get such further information as may be necessary to answer the questions that follow:

A. What is the title of your chief state health officer, and what is his name?

B. Who are the members of your state board of health?

C. What are some of the duties of the state board?

D. What are the duties and powers of a county board?

E. How is a village or city board of health organized?

F. What are the duties and powers of such a board?

G. Whose business is it to put a quarantine card on a house?

H. Under what circumstances may a quarantine card be legally taken down?

2. **Dramatizing the activities of a health board.** Proceed in your class or school to organize a mock board

FIG. 48. A mock trial, "The State *vs*. Lawler." It is probably the attorney for the prosecution who is addressing the court. (At a trial, the judge is referred to as "the court.") A witness under examination is seated in the chair near the judge. The group at the right includes "Mrs. Lawler" and her attorney; also "Angelina" and the clerk of the court. The jury is seated near the wall.

of health for a village, county, or city, depending on the kind of board that has control over the community in which you live. After this board has been organized, go through the procedure of ordering a quarantine on some house. If you have time, you can make your mock board of health act for your own school on cases of uncleanliness, disorder, school-yard behavior, and unhealthful conditions around schoolroom or grounds. Record in your notebook the answers to these questions:

A. Who are the officers of your mock board of health?

B. What powers have you given to your mock board?

C. What cases have you had before your mock board?

D. Why is a community better off for having a board of health?

Exercise II. Quarantining for Contagious Diseases

1. **Quarantine laws made interesting.** It will add interest to your study of the health rules and quarantine regulations of your state or county if you will dramatize a case of violation of the rules of quarantine. The case that follows was successfully dramatized in one of the schools of Nebraska. With adaptations, it can be made to suit the regulations of any state.

Mrs. Lawler's daughter, Angelina, comes to school showing symptoms of scarlet fever. Her teacher, Miss Efficiency, has on her desk a copy of Ritchie's *Primer of Sanitation*, and has learned to recognize these symptoms.

According to the "Laws, Rules, and Regulations" of the Nebraska Health Commission, where no physician has been called to attend a pupil sick with a contagious disease, it is the legal duty of a teacher to report the case to her school principal or to the county superintendent of schools, who in turn must report the case to the local member of the county board of health. Consequently, on the morning Angelina Lawler appears with her incipient case of scarlet fever, the teacher sends her home, notifies the county superintendent, who in turn informs the county health officer, and he, following the state regulations, visits the home of Angelina and posts a red quarantine card on the house.

Now, the Nebraska rules say that a scarlet-fever patient must remain in quarantine for thirty days. Our Miss Angelina is sent home, let us say, on December 10, and appears in school again on January 5. Mr. Good Citizen, knowing the danger to the school and to the community on account of Angelina's premature return, causes Angelina to be arrested for violating the quarantine law.

The case comes to court, and here is where our dramatization begins.

The parties at the trial are the county judge; the county attorney; the attorney for the defense; Mrs. Lawler; Angelina; one or two of their neighbors as witnesses for the defense; the witnesses for the prosecution, who are Mr. Good Citizen and several others who have knowledge of the case, among them the member of the local board of health; and the jury, the members of which may be selected from among the parents and other visitors invited to come to the school on the day set for the trial. The maximum fine is $25 for violating the law. Is Mrs. Lawler guilty?

Mrs. Lawler's defense is that on January 5 she discovered that the quarantine card was down. She supposed that the officer had removed it, and so sent Angelina to school. Besides, she maintains, the girl was perfectly well. The prosecution says that Mrs. Lawler was seen taking the card down late on the evening of January 2, and that the girl had discharges from her ears when she returned to school.

In working out the mock trial, you will need to ask questions of parents or others who have attended trials, to find out just how to conduct a case in court. You will also need to study the health laws of your state. You will find much to interest you in working out this trial. After you have held the trial, write in your notebook the answers to the questions that follow:

A. What pupils joined in your mock trial for violation of the quarantine laws and what parts did they take?

B. What was the special charge made against the defendant?

C. What was the verdict of the jury; and what was the action of the judge?

2. **Questions on quarantine.**

A. What does the word "quarantine" mean?

B. In your state, what diseases are to be quarantined?

C. Why are quarantine laws a good thing?

D. What is the duty of anyone who discovers that a quarantine law has been violated?

Exercise III. Hospitals and Sanitariums

1. **A visit to a hospital.** If possible, make a visit to a hospital, or let someone who knows about hospitals report on them. Then write in your notebook the answers to these questions:

A. Is your nearest hospital privately or publicly owned, or is it owned by an institution?

B. Is it a free hospital or a pay hospital?

C. How careful are the doctors and attendants to keep patients from being infected with germs

D. Why are very sick persons usually better off in a hospital than in a home?

E. Should there be a free hospital in every city or county for all very sick or badly injured persons?

F. What is a pesthouse, and what is its importance?

G. Where is your nearest hospital for the insane?

H. Where is your nearest institution for the feeble-minded?

2. **Sanitariums.**

A. How is a sanitarium different from a hospital?

B. Why is a sanitarium sometimes better for a convalescent patient than his own home?

C. Should every large community have a free sanitarium?

D. Where is the sanitarium nearest to your home?

E. Distinguish between the term "sanitarium" and the term "sanatorium."

STUDY TWENTY-NINE

INSPECTION OF FOODS AND SUPERVISION OF FOOD PRODUCTION

MORE important than care of the sick and quarantine is prevention of infection in the first place. Among the most important means of prevention is the inspection of the local milk supply; and back of this is the inspection of dairy herds. Further guarding the health of the people is the United States Government with its inspection of meats, and with its pure-food laws. Then, too, there are state and local rules for keeping in a sanitary condition all markets where foods of any description are handled. But with all the laws and health officers we may have, the final guarding of the public health still depends on the people themselves. We must be on the alert to see that the laws are obeyed, and that we ourselves do what they require. The plan for food inspections in this Study will point the way for you to be of service not only to your community, but also to the well-meaning tradesmen who handle much of the people's food.

EXERCISE I. STUDIES OF MILK

1. **Sediment in milk.** Take a small pad of absorbent cotton and on it pour the last small portion of milk out of the container in which milk is supplied to your home.

A. Do you find on the pad any specks, sediment, or colorations?

B. If so, how do you think they got into the milk?

C. Why does milk have so many germs in it?

2. **Milk diluted with water.** To find out whether milk has been watered you will need a hydrometer. If you do not have one but have a dairy thermometer you may use

FIG. 49. The hydrometer test to determine whether or not milk has been adulterated with water.

that. If the dairy thermometer does not float erect in water, wrap enough fine wire around the bottom of the thermometer to make it float vertically or nearly so. The higher degree marks should stand a little above the surface of the water. Put the milk to be tested into a tall, narrow vessel, such as a quart milk bottle or a long flower vase, and float the hydrometer or the thermometer in this milk. If the instrument floats higher than it did in the water, the milk is heavier than the water; but if lower, the milk is lighter than the water.

A. Is milk heavier or lighter than water?

B. When you add water to the sample of milk, does the instrument float higher or lower than before?

3. **A dangerous preservative.** Formalin is sometimes used by unscrupulus dairymen to keep milk from

spoiling soon, for formalin, you will remember, is a germ killer. But it is poisonous to drink and should never be put into milk that is used for food.

Put a few drops of formalin or formaldehyde into a sample of milk. Now, to show the presence of formalin in this sample, put into it a drop or two of a solution of *ferrous chlorid.* Very carefully pour a little strong sulfuric acid into the bottle at one side, holding the bottle well away from anybody's face. The ring of color in the milk shows that the milk has been treated with formalin.

A. Describe the ring of color that is a test for formalin in milk.

B. Why is Pasteurizing milk a better way to keep it from spoiling than putting formalin into it?

Exercise II. Inspection of Food Sources

1. **Inspection of milk sources.** The following questions are for use in a survey of a dairy, or of any place where milk is supplied for family use. Make a visit to some such source of milk supply and write in your notebook the answers to the questions that follow:

A. Is the barnyard clean and well drained?

B. Is the cow barn well adapted to its purpose?

C. Is the ground floor kept quite clean?

D. Is the place kept reasonably free from cobwebs and other overhanging litter?

E. Is the floor moisture-proof and rat-proof?

F. Are there screens to keep flies out?

G. Are the cow stables kept clean, and are there gutters to take care of the droppings?

H. Are the cows kept quite clean?

I. Have they passed the tuberculin test?

J. Do the cows have wholesome water to drink?

K. Do the milkers wash and dry the cows' udders before milking?

L. Are their hands clean while milking?

M. Do they wear clean, special milking suits?

N. Are the men or women who handle the milk all in good health?

O. Are the milking utensils kept perfectly clean?

P. Is the milk pail provided with a cover?

Q. Is the milking done through gauze over the milk pail?

R. Is the gauze regularly boiled and dried before using?

S. Is there a milk house separate from the barn and used for no other purpose than for keeping milk?

T. Is the milk house thoroughly cleaned and well kept?

U. Is the fresh milk cooled to at least 50° Fahrenheit as soon as possible after being taken from the cow? If so, why?

2. **Inspection of a bakery.** Visit a bakery, and then in your notebook write the answers to the questions that follow:

A. Is the building in a sanitary location?

B. Are the premises generally kept clean?

C. Is every precaution taken against rats?

D. Is every precaution taken against cockroaches and other vermin?

E. Is the building well screened in summer?

F. Is the place well lighted?

G. Are the rooms kept clean and free from flies?

H. Do the clerks and bakers wear aprons?

I. Are they thoroughly clean in dress and habits?

J. Are the employees free from contagious diseases?

K. Are pet animals kept out of the bakery?

L. Are utensils and machines kept quite clean?

M. Is the garbage kept covered in metal cases?

N. Are the bakery products kept under cover in show cases or elsewhere?

O. Are they well wrapped when sent out?

3. **Inspection of a meat market.** Visit a meat market and record in your notebook the answers to the questions that follow:

A. Is the market in a sanitary location?

B. Is the building well constructed?

C. Is it rat-proof?

D. Is the building well screened and free from flies?

E. Are the surroundings kept clean?

F. Are waste products kept in metal cans?

G. Is all meat protected from flies and dust?

H. Is the meat kept so that it cannot be freely handled by marketers?

I. Are the counters, refrigerators, and other meat containers kept thoroughly clean?

J. Are the clerks clean and healthy-looking?

K. Are they protected with clean aprons?

L. Are all utensils thoroughly cleaned daily?

M. Is the meat supply *Federally* inspected?

N. Is it *city* or *village* inspected?

O. Are the carcasses kept carefully wrapped while being transported to the market?

P. Is the meat delivered in covered wagons and kept wrapped until it reaches the purchaser?

Q. Are the delivery wagons clean?

STUDY THIRTY

SURVEYS OF SCHOOLHOUSE AND HOME

THE old Greeks had a fable about their great god Zeus and the first man. Zeus gave the man one wallet in which to carry his own faults and another in which to carry the faults of others. The wallets were connected with a pair of straps, and the man decided to carry them suspended from his shoulders. He stuck his head between the straps, and this left one wallet resting on his back and the other just below his chest. But the wallet for his own faults was the one that swung at his back, while the one for his neighbors' faults rested before his eyes; and to this day it is much easier for men to see the faults of others than to see their own. The moral of this fable here is that you should see to it that your own surroundings are as sanitary as you can make them before you inspect the surroundings of others.

EXERCISE I. A SURVEY OF YOUR SCHOOL BUILDING

Keeping your own school building in mind, answer in your notebook the questions that follow. Allow two points as a maximum credit on each question. If the conditions in your school are quite different from those that a question seems to presuppose, give the question a liberal interpretation, and mark a credit appropriate to your school. For instance, in the questions about the well and the school sewage system, if you do not have a well or an outhouse at your school, give your school full credit if the conditions of sanitation are fully met in some other way.

1. Is there a great deal of mud around the schoolhouse when it rains?

FIG. 50. The Prescott School at Lincoln, Nebraska. The building is thoroughly modern; there is plenty of window space, and the grounds and walks are attractive.

2. Is there a good walk leading from the road or street to the schoolhouse?

3. Are the school grounds well drained; that is, free from all standing water in wet weather?

4. Are there trees to relieve the excessive heat in summer and to serve as a windbreak in winter?

5. Is there enough playground space that is suitable for healthful physical exercise?

6. Is there a well of pure water on the grounds or conveniently accessible to the building, and is it so covered as absolutely to prevent the inflow of surface water and all filth?

7. Are the outbuildings in good condition; that is, are they rainproof, do the doors swing freely, are the interior constructions adapted to their purposes, and are the buildings clean and free from unsightly marks?

8. Does each closet have a suitable screen in front of it?

9. Is there a suitable container for waste; as (1) a dry-earth closet, (2) a septic-tank container, or (3) a water-tight vault or box?

10. Are the outbuildings thoroughly screened against insects and easily cleanable at frequent intervals?

11. Are the floors of the outbuildings scrubbed at least once a week, and are the windows washed at least once a month?

12. Are board floors of the school building oiled at least twice a year?

13. Are the floors, doors, walls, windows, ceilings, and furniture of the school building kept free from accumulations of dirt and dust?

14. Are the floors swept daily with an effective sweeping powder?

15. Are the desks and other school furniture well dusted with a damp cloth?

16. Is the schoolroom provided with a suitable and effective heating apparatus, either a well-jacketed stove or a well-installed furnace?

17. Is the school building itself in such a condition that with a good heating apparatus, a proper temperature can be maintained?

18. Is there provision for the evaporation of a considerable quantity of moisture at the source of heat supply, in order properly to humidify the air?

19. Is a good thermometer kept at the height of about four feet above the floor of the room and convenient to the teacher?

20. Is a fairly uniform temperature of about 68° Fahrenheit maintained in the schoolroom all the time?

21. Is the heating apparatus in charge of some one who is thoroughly capable of managing it efficiently and economically?

22. Is the fuel abundant and in good condition, and is suitable kindling provided?

23. Are there at least 200 cubic feet of space for each pupil in the room?

24. For supplying fresh air to the heating apparatus, is there an inlet of as many square feet in cross section as there are rooms to heat; that is, if there are five rooms, does the opening into the fresh air pipe have an area of at least five square feet?

25. Is there a foul-air exit at least 16 inches by 16 inches in area in each room? This should be on the wall near the floor on the side of the room from which the heat supply comes.

26. If the conditions specified in questions 24 and 25 do not exist, is there a provision for open windows in mild weather and for window-board ventilation under all conditions?

27. Whatever the system of ventilation, is it the practice to flush the room with fresh air at intermission times?

28. Is the air of the room regularly renewed about once every 15 minutes?

29. Is the total window-glass space equal to about one fourth or one fifth of the floor space?

30. Are the sources of light on the long wall of each class room and on the left of the seated pupils, except the left-handed ones?

31. Are the principal windows on either the east or the west side of the rooms, so that the sun can shine in directly during a part of the school day?

32. Are the ceilings colored white or cream; the walls, light gray or light green; and the blackboards, black or dark green but not glossy?

33. If there are windows to the rear or to the right of

the pupils, are their bases at least 7 feet from the floor?

34. Are neutral-colored window shades provided for both the tops and bottoms of the windows, and are the shades regularly kept in correct adjustment?

35. Are the school seats single, and are those of the same size in separate rows?

36. Are the seats adjustable, and are they fitted to the child at first and refitted every four months thereafter?

37. Are the devices for using ink kept in good order, and are the desks kept free from ink marks and other defacements?

38. Are the decorations of the room simple and refined?

39. Are the seats, teacher's desk, and other furniture of such a nature as to permit ready sweeping and cleaning underneath?

40. Are the desks so related to the seats that a plumb bob dropped from the rear edge of a desk will fall two inches back from the front edge of the seat?

41. Are there seats provided for the left-handed children, so set as to permit the light to come in over their right shoulders while they are writing?

42. Are the children's books kept in good order in their desks, and is there insistence on general freedom from litter in and about the desks?

43. Is the drinking water wholesome and free from the possibility of germ infection?

44. Is there easy access to drinking water any time of day without the necessity of disturbing the school in any way?

45. Is there plenty of chance to get a drink when the demand is heavy, as at the close of intermissions?

46. If individual drinking cups are used, are they kept where they are free from schoolroom dust?

47. If individual cups are used, is the container for the drinking water so fixed that the water runs into the cups and cannot be dipped into?

48. Are there facilities for the pupils' washing their hands, (*a*) after the use of the toilet, (*b*) after handling soiled objects such as chalk and baseballs, and (*c*) just before eating luncheon?

49. Are there individual towels kept in suitable receptacles, or, better yet, paper towels conveniently at hand?

50. Is there medical supervision in your school?

51. What percentage does your school building score on this survey?

Exercise II. A Sanitary Survey of Your Home

The following survey questions are modified from Hoag and Terman's *Health Work in the Schools.* Allow three points as the highest credit on each of the following items, and throw in one point for good measure at the last, as you record answers to the questions.

1. Is the yard well drained, so that no surface water stands close to the house?
2. Is the drainage natural or artificial?
3. Is there no stagnant water near for breeding mosquitoes?
4. Are there no breeding places for flies near the house?
5. Is the yard free from rubbish and litter?
6. Is the yard kept attractive through the year?
7. Are the outbuildings kept in good condition?
8. Is the outside privy, if any, kept completely sanitary?
9. Is the cesspool, if any, cleaned out when necessary?
10. Are wells and cisterns carefully protected?

11. Has the house good exposure to sun and air?

12. Is the building kept in good repair?

13. Does the air inside the house seem fresh and odorless?

14. Is the house free from flies and mosquitoes?

15. Is the house free from rats and mice?

16. Is there an adequate and efficient heating system?

17. Are the provisions for fresh and waste water effective?

18. Is the house lighting sufficient and well placed?

19. Can floor coverings, if any, be easily removed and cleaned?

20. Is the house free from useless hangings and decorations?

21. Are the floors clean and smooth?

22. Are the inside toilets, if any, thoroughly sanitary?

23. Do the sleeping rooms have sunlight part of the day?

24. Are the sleeping and living rooms easy to ventilate?

25. Are the beds where air currents strike them?

26. Are bed coverings frequently aired and cleaned?

27. Does the kitchen have a cooler-closet or ice box?

28. Is food kept where it is free from dust and insects?

29. Are clean towels and other cleaning cloths provided?

30. Is there a light, dry room for storing vegetables?

31. Are the basement rooms, if any, kept in clean, orderly condition?

32. Is the attic kept in clean, orderly condition?

33. Is the roof of the house free from leaks?

34. What percentage of complete sanitation does your home score?

PART THREE

Personal Hygiene: Physiology

TO THE BOYS AND GIRLS

Imagine a little wayside pond with about twelve gallons of water in it and with something like four or five hundred trillions of microscopic, one-celled animals living in it, each one going hither and thither to get food for its own sustenance.

Think of this same quantity of water and an equally large mass of cells, now organized so that the cells practice a division of labor and hold fixed and interdependent positions. Instead of moving about through the liquid to absorb foodstuff, the cells have their food brought to them by flowing liquid. This liquid is made to circulate among the cells by the work of a special portion of the cells.

Conceive this mass of cells and water as enclosed in a covering of skin and given the form of a human being, and you will have in mind a crude but essentially true picture of a human body. Man, physically, is then a sort of animated pond, a walking reservoir, but a very wonderful one withal. Indeed, the greatest of marvels is the human body, which has been given to each of us for a temporary dwelling place.

While you are reading this page, three billions of red blood corpuscles are being manufactured in the red marrow of your bones, to say nothing of the multitudes of other activities within your wonderful cellular organization. The study of these cell activities is known as *physiology*. What hygiene is, you know from your study of Part One of these studies; and what sanitation is you know from your study of Part Two.

In Part Three, in addition to a further study of hygiene, you are to study something of *Physiology*, which is *the science of the workings of the cells of the healthy body in maintaining life.*

STUDY THIRTY-ONE

YOUR FOODS

A SKILLFUL worker in metals can take quantities of copper, tin, and zinc and combine them into different metallic substances by varying the proportion of the metals in each mixture. One mixture, for instance, gives him the alloy of which a common cent is made, another yields bell metal, and still another provides the material for bronze statuary.

Now, just as the numerous metallic articles around us are made from a comparatively few primary metals, so the numerous things we eat are made up of a comparatively few primary sorts of food. Thus it happens that we may have many different kinds of foods furnished for our meals, all made from a natural or artificial combination of only five or six primary foodstuffs. A knowledge of the most common and important of these primary foodstuffs is very necessary to anyone who wishes to select his foods intelligently.

EXERCISE I. WHAT YOUR FOODS ARE MADE OF

Just as there are ways to find out whether a given piece of metal contains zinc, copper, or other elements, so there are ways to find out whether any particular food on your table contains any one of the primary food materials. You will find it interesting to make some of the tests for at least five different kinds of primary food materials.

1. **Proteins and how to identify them.** The most important of all the primary food materials is called *protein*. (Be careful to give three syllables to the pronunciation of this word.) Its importance is due to the fact that it is the only kind of primary food material for which

FIG. 51. A hot-lunch club is often successfully conducted in rural schools. The working officers are a cook, a housekeeper, and a bookkeeper; and the members serve in these places by turns. Besides getting hot luncheons at noon, the students have a chance to study foods and costs.

there is no substitute. We could not live without one or more of the several varieties of proteins in our daily diet.

Just as there is a way to tell whether there is copper in any given alloy, so there is a way to identify proteins in specimens of the class of materials from which we get our foods. To make a test for proteins you will need a wire or a hatpin, and an alcohol lamp. An ordinary kerosene lamp will serve in place of the alcohol lamp, though it is not so convenient. Put a common feather on the point of the wire, and thrust the feather into the flame. Note the peculiar odor that comes from the burning feather. Any material can be known to have protein in it if, when burned, it yields an odor like that coming from the feather; and this is true even though other odors are mingled with this odor. Each pupil in the class should

make at least two tests for proteins in two samples of common table foods that have been brought to school. From the work of all the pupils, complete the record in the table outlined below:

FOOD TESTS FOR PROTEINS

FOODS TESTED	EFFECTS OF THE BURNING	CONCLUSIONS
Lean meat	Odor like burned feather	Protein present
Butter	No odor like burned feather	No protein present
Baked beans	....	....
Cooked peas	....	....
Peanuts..........	....	....
Boiled egg (yolk)	....	....
Boiled egg (white)	....	....
Scum from boiled milk	....	....
Gum from chewed wheat grains	....	....

2. **Carbohydrates and how to identify them.** The name of the second most important kind of food is easily pronounced if you divide it up into syllables, thus: *car-bo-hy'drates*. There are two clases of carbohydrates that we need to know about and that we can test: namely, starches and sugars.

A. Starches. Examine a sample of pulverized starch, and make a starch test as follows: To a small bit of powdered starch in a spoon add a drop or two of tincture of iodine. The starch will be turned a light or a dark blue,

according as the proportion of starch in the sample is small or great. Test in the same way samples of the foods that are listed following this paragraph; and test as many other foods as you can, at least two tests being made by each pupil in the hygiene class.

Food Tests for Starches

Foods Tested for Starch	Effects of Iodine	Conclusions
Bread	Dark blue	Much starch
Peanuts	Light blue	Little starch
Meat	No change	....
White potato	....	....
Sweet potato	....	....
Beans	....	....
Banana	....	....
Cane sugar	....	....
Rice	....	....
Macaroni	....	....

B. Sugars. There are two ordinary kinds of sugar, commonly known as cane sugar and grape sugar, but coming from many other sources besides sugar cane and grapes. If your teacher thinks it desirable, she can make the first test for grape sugar herself, in the presence of the class. The test is made by putting a raisin in a test tube or small vial, adding enough water to cover the rai-

sin, and then putting in two or three drops of either Fehling's or Haines' solution, which can be bought at any drug store. On boiling the mixture of raisin water and the testing solution over the flame of an alcohol lamp, the liquid will turn reddish brown, for grape sugar is present. No other kind of sugar will yield this test. Apply the test to several other common foods, such as are suggested in the table below, and record results and conclusions.

FOOD TESTS FOR GRAPE SUGAR

FOODS TESTED	EFFECTS OF THE TEST SOLUTION	CONCLUSIONS
Raisin	Reddish-brown color	Grape sugar present
White cane sugar	Color remains blue	No grape sugar
Brown cane sugar	Reddish-brown color	Grape sugar present
White potato	....	....
Sweet potato	....	....
Bread	....	....
Cake	....	....
Candy	....	....
Molasses	....	....

3. **Fats and oils and how to identify them.** The primary foodstuff third in importance is fat, with its liquid variety, oil. The simple test for fats or oils consists in pressing the sample of food down on a piece of writing

paper. If the paper is left somewhat transparent after drying, oil is present in the food tested. The pupils of the class should each bring to school two samples of common foods and make tests to complete the following table:

FOOD TESTS FOR FATS AND OILS

FOODS TESTED FOR FATS AND OILS	EFFECTS OF THE TESTS	CONCLUSIONS
Butter	Paper quite transparent	Much fat
Yolk of egg	Paper partly transparent	Some fat
Peanuts	. . . .	. . . .
Walnuts	. . . .	. . . .
Cheese	. . . .	. . . .
Beef suet	. . . .	. . . .
White of egg	. . . .	. . . .

4. **Ash and how to identify it.** A fourth variety of primary foodstuff is known as "ash." This ash includes common salt and many other mineral salts. The way to test for ash in any food is to burn a sample of the food completely. The material left is the ash that was in the food. For a careful test, the food must be burned in a very hot place in order to burn up all the other primary foodstuffs and leave the ash only unburned. To the table that follows add the names of five additional foods that will leave ash when burned.

Food Tests for Ash

Foods Tested	Effect of Burning	Conclusions
Oatmeal	Ash remains	Mineral salts present
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....

5. **Water as a primary foodstuff.** We commonly think of water as a beverage, but it is a primary food as well, because it is used in building body tissue. It is so easily recognized that it does not need to be tested. Its presence in food, if in any quantity, is shown by the fact that the food will dry out on standing. What are the names of ten foods that you have reason to believe contain water in an appreciable amount?

Exercise II. Questions for Investigation

1. When carbohydrates are taken apart, what chemical elements are they found to be made of?
2. What three elements are fats and oils made of?
3. What three elements are present in starches and sugars?
4. List ten foods that are rich in proteins.
5. List ten foods that are rich in starches.

6. List ten foods rich in fats or oils.
7. Name ten foods yielding minerals.
8. What are vitamins?
9. Name five foods yielding vitamins.
10. What primary foodstuffs are present in the following common foods: milk; white bread; lean meat; rice; white potato; sweet potato; peas and beans; corn bread; celery?
11. Define vegetable foods, and name ten of them.
12. Define animal foods, and name ten of them.
13. Of what use is it to know the primary foodstuffs in the common foods?
14. List some good habits with regard to the kinds of foods you eat.

STUDY THIRTY-TWO

HOW FOODS ARE DIGESTED

You have been told that food for the cells making up the body is dissolved in water and is then carried by the circulating water to the cells that need the food. You have just been studying the kinds of foods the body uses, and you know that a good many of them will not dissolve in water unless something is done to make them soluble. Your next step in the study of the way in which the body is nourished is to learn how the foods may be made to dissolve in water. The process by which foods are rendered soluble in the liquid part of the blood is called *digestion*. A few experiments will help you to understand some of the forms of this interesting process.

Exercise I. Processes of Digestion

1. **Starch and water.** Put some raw or cooked starch into a glass of water. Does water dissolve starch; that is, does water take the starch up into itself so you can no longer see any of the starch?

2. **Sugar and water.** Put a teaspoonful of sugar into a glass of water and stir once or twice. What happens to the sugar in the water?

3. **Effect of saliva on starch.** In a test tube or vial two thirds full of water, boil a quantity of starch that will lie on a penknife point. Pour half of the starch paste that results from this boiling into another test tube or vial. Into one of your two samples of starch paste put as much as a teaspoonful of saliva which has previously been collected, and set the tube aside in a warm place for 10 minutes. Keep the other sample of starch paste without change for the same time. Then put several drops of

Fig. 52. A noonday luncheon served in the classroom. Foods served warm are more readily digested than foods served cold. In many schools a separate lunchroom is provided, and that is to be desired.

Fehling's or Haines' solution in each portion of starch paste and proceed to bring each to the boiling point for a moment by holding the tube over the flame.

A. What does saliva do to starch paste?

B. How do you know that saliva does this?

4. **Why starch needs to be digested.** Secure from a butcher two pieces, each about 3 inches long, of the small intestine of some animal. Wash these out thoroughly and tie a string around one end of each so as to make it into a pocket. Into one pocket, by means of a funnel, put some starch paste; and into the other put some molasses or strained honey. Now tie the upper ends of the two pockets, put them into separate glasses of water, and let them remain there for 24 hours. Then pour several drops of tincture of iodine into the water containing the intestine with starch in it.

A. Did the starch in your experiment get out into the water around the piece of intestine, and if not, why not?

B. Pour some water from the other glass into a test tube or vial, add a few drops of Fehling's or Haines' solution, and bring to a boil. What do you find to be in the water?

C. What do this study and the prior study show as to the ability of intestine wall to transmit food?

D. Why does starch need to be changed to sugar in the food canal?

5. Digestion of other foods. Most foods have to be digested before they can be useful to the body, as you have just seen. Starch is the only kind of food that saliva acts on. The other primary foodstuffs, and starch as well, are digested in other parts of the food canal.

A. Do common salt and water have to be digested, and if not, why not?

B. Why do lean meat, fat meat, and butter have to be digested?

6. How the teeth help digestion. Turn to Part One, Study Six of this book and follow out the directions there given for the study of the teeth.

7. The condition of your teeth. Have your teeth thoroughly examined and enter in your notebook the report on the condition of each one.

	UPPER TEETH		LOWER TEETH	
	Right	Left	Right	Left
A. Middle incisor	....	....	....	....
B. Lateral incisor	....	....	....	....
C. Canine	....	....	....	....
D. First bicuspid	....	....	....	....
E. Second bicuspid	....	....	....	....
F. First molar	....	....	....	....
G. Second molar	....	....	....	....

Exercise II. Questions for Investigation

1. What is digestion?
2. What is an enzyme?
3. Referring to Figure 53, name the parts of the alimentary canal.
4. Tell what happens to the different primary foodstuffs in a bite of buttered cold ham sandwich as it passes down the following portions of the food canal: the mouth; the esophagus; the stomach; the small intestine; the large intestine.
5. Be able to trace on your body the outline of your stomach and liver, showing their locations.
6. Similarly, be able to show the location of each of the salivary glands.
7. What is a gland?
8. What are the salivary glands?
9. What is gastric juice?
10. Where is the pancreas?

Fig. 53. A model of the alimentary canal.

11. What does it secrete?
12. What is the vermiform appendix?
13. What is appendicitis?
14. Why should waste food not be left lying long in the large intestine?
15. Of what four kinds of material is a tooth made?
16. What are the three parts of a tooth?
17. What are the temporary teeth?
18. What are the permanent teeth?
19. What is the most common cause of tooth decay?
20. What are some abuses of teeth, in consequence of which they may decay?
21. How do bad teeth injure health?
22. How may you help to preserve your teeth?
23. What are dental plaques?
24. How should the gums be cared for?
25. How can irregular teeth be straightened?
26. How often should one visit a dentist?
27. Write in your notebook a list of good-health practices that aid digestion.

STUDY THIRTY-THREE

HOW FOODS SERVE THE BODY

A GALLON of high-grade gasoline will drive an automobile 20 miles or more. A poorer grade will drive it hardly 15 miles. An autoist knows that the quantity of gasoline he must use on a given trip depends in part on the quality of the gasoline he puts into the tank. Similarly the power you get out of your food depends also in part on the kind of food you eat. You have come now to an important experiment that will show some of the differences in food quality. The experiment will have to be performed before the whole class in hygiene, but you can help your teacher in getting the apparatus together.

EXERCISE I. THE FUEL VALUE OF FOODS

1. **Making a calorimeter.** For your studies of the relative heating powers of the primary foodstuffs you will need four homemade *calorimeters* or heat measurers, like the one shown in Figure 54. To make the four calorimeters you will need a dozen pie pans, 16 ten-penny nails, 4 pieces of fly screening measuring 4 by 6 inches, and 4 boards about 10 inches square.

Take a piece of board 10 or 12 inches square and on it set a good-sized pie pan. Around the pan, at equal intervals, drive 4 ten-penny nails about half an inch into the wood. Let them slant in over the edge of the pan so that they will support on their heads the outer rim of a second pan. Invert a third pan and place it over the second pan as a lid.

Set in the first pan a piece of metal fly screening about 7 inches long and 5 inches wide, with an inch of the screening bent down at each end. This will make a table-

FIG. 54. The two calorimeters at the center are ready for lighting, while the other two are being prepared. The boy is weighing material to be tested.

like support 5 inches square and with end legs an inch high. On this "table" is to be laid a piece of unglazed paper cut in a circle exactly the size of the pan, including the rim.

In your notebook make a little drawing of your calorimeter.

2. **Testing the fuel value of foods.** For your experiment you will need, besides the calorimeters, some kerosene, a teaspoon, scales to weigh in fractions of an ounce, and samples of starch or sugar, dried beef, butter, a dairy thermometer, and a gallon of very cold water.

When all is ready for the demonstration of the heat values of the three kinds of "fuel" foods, arrange the four calorimeters in a row on a table or desk before the class. Remove the two upper pans from one of the calorimeters,

and on the center of its circular paper carefully pour an even teaspoonful of kerosene. Replace the second pan on the nail heads and very carefully pour into it an exact pint of the ice-cold water. Take the exact temperature of the water in the pan and then cover it with the third pan inverted.

Treat the second calorimeter in the same way, but put one sixth of an ounce (5 grams, or the weight of a five-cent piece) of starch or sugar on the paper before adding kerosene. Be careful to see that the food and the kerosene are thoroughly mixed on the paper without the loss of any materials. Treat the third calorimeter as the second, but use one-sixth of an ounce of dried beef (dried in an oven to a crisp, but not charred) in place of the starch. Into the fourth calorimeter, put one sixth of an ounce of pure butter instead of the starch or beef.

When everything is ready, set fire to all four papers. If necessary, do some "poking" with a small metal "poker" to keep the fires going. As soon as each fire goes out completely, once more take the temperature of the water in each pan. Record the results in your notebook, as indicated in the form of table that follows:

Table of Fuel Values

Temperature	First Reading	Second Reading	Difference	Difference Minus the Effect of Kerosene
Pan 1 (kerosene only)	....	....	....	....
Pan 2 (carbohydrate)	....	....	....	....
Pan 3 (protein)	....	....	....	....
Pan 4 (fat)	....	....	....	....

To get the figures for the fourth column above, subtract the difference in temperature shown in the third column for the kerosene alone (Pan 1) from each of the remaining differences in Column 3. The fourth column now shows the heating power of a sixth of an ounce of carbohydrate (starch), of protein (dried beef) and of fat (butter). If the work has been carefully done the beef and the starch will show about the same results in Column 4, while the butter will show about twice as great a result. The values in Column 4 are called *heat units.* If you have used a Fahrenheit thermometer and a full pint of water (which weighs about a pound) you have for each degree of heat an English heat unit of energy. A heat unit may be defined as an amount of heat that will raise a unit weight of water through one degree of temperature. The English unit employs a pound of water and a degree of heat measured by a Fahrenheit thermometer. The French unit (called a *calorie*) employs a kilogram of water and a degree of heat measured on a Centigrade thermometer.

It must be recognized that in your experiment with the calorimeters there was lost into the surrounding air about half the heat from the burning substances. You must, therefore, double the results in Column 4 of your table to get a result near to what a sixth of an ounce of the food in each case would yield in heat units. Now multiply the doubled results by 6 so as to indicate roughly what a whole ounce of each kind of foodstuff will yield in heating power.

A. What is the heat-unit value of an ounce of starch (carbohydrate)?

B. What is the heat-unit value of an ounce of beef (protein)?

C. What is the heat-unit value of an ounce of butter?

3. **A well-balanced ration.** Careful scientists say that a well-balanced ration per meal for an average adult consists of about 5 ounces of dry carbohydrates, 1 ounce of dry protein, and 1 ounce of fat. Remember these figures and these proportions. An average day's needs for all three meals will thus come to 21 ounces of dry foodstuff. How many heat units would there be in a well-balanced ration for a day, as you calculate them from the values you got in your calorimeter experiments?

4. **Review.** Refer to experiments in connection with food studies, which were made in Studies Seven and Eight of Part One. What have you learned from that review?

Exercise II. Foods for Building and Repairing Tissues

1. **Proteins as tissue builders.** Fill two test tubes or small bottles half full of clear rain water. To one of these add sugar equal to one twentieth by weight of the water. Fill a third similar bottle two thirds full of Pasteurized skimmed milk or separated milk. Ordinary milk contains about 5 per cent of sugar and 2 per cent of protein. To each of your bottles now add a drop of fresh liquid yeast. Set the three bottles aside in a warm place for a day, then place a drop of liquid from each bottle on three separate microscopic slides. Examine each drop through a compound microscope that will magnify about a hundred diameters, and note which drop has the most yeast plants growing in it. Which drop has the most and which the fewest plants? What does this show?

2. **Salts as tissue builders.** Find out, from any source, the nature and cause of the disease known as "rickets."

A. What is one function of the salts or "ash" in foods?

B. What is another function of salts in the blood?

EXERCISE III. QUESTIONS FOR INVESTIGATION

1. What is a food?
2. What two purposes do carbohydrates serve in the body?
3. What two purposes do fats and oils serve in the body?
4. What three purposes do proteins serve in the body?
5. Why is milk so good a food for animals that are growing?
6. Why are eggs so excellent a food?
7. What causes scurvy?
8. What is pellagra, and what causes it?
9. If you eat more carbohydrates and fats than you need, what does your body do with them?
10. If you eat more proteins than you need, what becomes of them?
11. Why is it not good for one to eat more meat and other proteins than the food canal can absorb, even in their digested form?
12. Why should so much gas form in the bowels when one eats excess proteins?
13. What is meant by the term "vegetarian"?
14. Who usually has the greater endurance, a vegetarian or a meat eater?
15. Give four reasons why it is wise to eat meats only moderately.
16. Why are fruits and vegetables very healthful for most people?
17. Why is constipation a great enemy of good health?
18. Why should you chew your food thoroughly before swallowing it?
19. What are some good habits of eating for you to form?

STUDY THIRTY-FOUR

STIMULANTS, NARCOTICS, AND DRUGS

About one-fifth of the air you ordinarily breathe is oxygen. If the air were wholly oxygen, do you think your lungs would be as large as they are, since the only part of the air that the lungs use is the oxygen? If the pull of gravity were twice what it is, would your bones be stronger and your muscles more powerful? Man has grown in a wonderful way to fit into the world in which he lives; and just as a fish cannot live out of water, so man cannot endure any very great departure from his natural way of living. It is because their use is not natural to man that stimulants, narcotics, and drugs are so demoralizing in their effects. Even the common forms of drugs do some harm, because they are unnatural. Under some conditions, however, there are drugs that temporarily do more good than harm; but they should be taken only on the advice of a skilled physician. It will be worth while to study some of the common forms of drugs at first hand.

Exercise I. Common Stimulants

1. **Tea and coffee.** Recall or repeat the work on tea and coffee in Study Seven, Part One.

A. What is a stimulant?

B. What is the stimulant in tea and coffee?

C. What is the astringent in tea and coffee?

D. What is the way to make tea and coffee so they will be least harmful?

E. Why are tea and coffee not wholesome for boys and girls?

2. **Cocoa.** Examine a sample of powdered cocoa used in making beverages. Test it for oil or fat, by pressing a

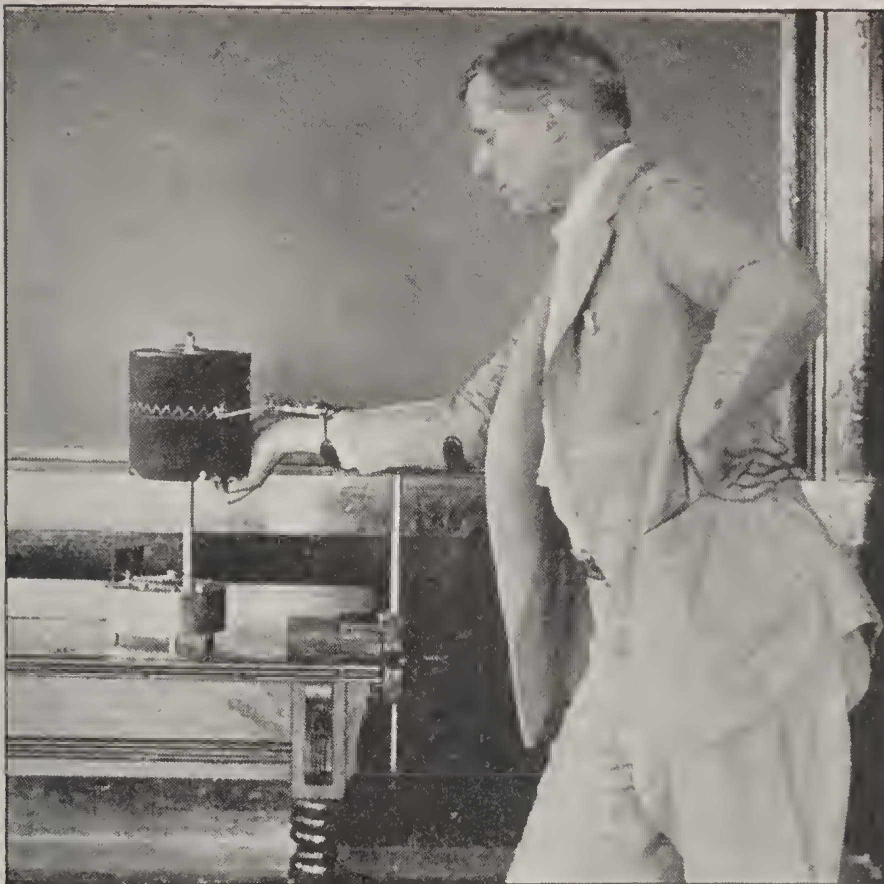

Fig. 55. The little machine, called a *sphygmograph*, is fixed to the wrist for making a pulse record. The record is traced on the smoked paper around the revolving drum, called the *kymograph*. The effect of tobacco shows itself in the user's pulse.

bit of it down on glazed paper to see if the paper becomes transparent. Test another small quantity of it for grape sugar by the use of Fehling's or Haines' solution. In addition to the food materials, there is in cocoa a stimulating substance somewhat like that in tea and coffee. This is called *theobromine*. Cocoa contains no astringent substance as do tea and coffee.

A. What is the appearance of cocoa used for beverages?

B. What primary food materials, if any, does it contain?

C. Why is cocoa more wholesome than tea or coffee?

Exercise II. Common Narcotics

1. **Alcohol.** This substance was long regarded as a stimulant when taken in small quantities, and as a narcotic or deadening substance when taken in larger quantities. The view now held is that alcohol is always a narcotic, for while it sometimes *seems* to stimulate, it does not really do so but is a deadener from the very first.

It happens that there are two sets of nerves that control the heart. One set makes the heart beat slower and the other set makes the heart beat faster. Alcohol in the blood acts on the former set of nerves first and deadens them, so that the second set of nerves acts unopposed. This makes the heart beat vigorously and sends blood rapidly to skin, muscles, and brain; and the person then seems to be excited. If a man driving a spirited horse loses the lines, the horse goes faster, not because he has been excited, but because the restraint has been taken off and he is left free to go as fast as he will. So, with the heart. The man who fills up on alcohol is like a driver who throws his lines away. But alcohol continues to work on a man's nerves and presently begins to deaden the second or *excitor* set of nerves also. After that it is easy to see that alcohol is a narcotic, for the man's heart begins to slow down and all his movements become slack.

Recall or repeat the experiment with alcohol in Study Seven, Part One.

A. What is the difference in effects between a stimulant and a narcotic?

B. What is the appearance of alcohol?

C. What are two important industrial uses of alcohol?

D. What is the effect of alcohol on cell substance?

E. In what two ways can you test for the presence of alcohol in a liquid?

F. Why do you suppose people have ever drunk alcoholic beverages?

G. By examining the labels on patent medicine bottles, find out the percentage of grain (ethyl) alcohol in each of the proprietary "remedies" listed: Peruna, Lydia E. Pinkham's Vegetable Compound, Hostetter's Bitters, Hood's Sarsaparilla, Warner's Safe Cure, Tanlac, Jaynes' Expectorant, Wakefield's Blackberry Balsam, Mrs. Winslow's Soothing Syrup, and Castoria.

2. **Tobacco.** There is reason to believe that tobacco acts in much the same way that alcohol does, tending to excite heart action immediately after it is chewed or smoked, but a little later producing a slowing-down effect. Look at the picture, Figure 55, to see how a pulse-tracing machine is used to tell the effect of the use of tobacco on heart action. Then study the records of pulse waves shown below and answer the questions that follow:

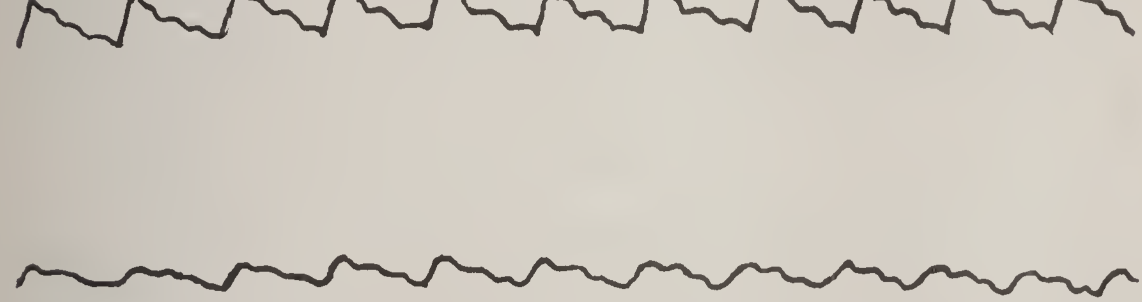

FIG. 56. These lines represent three different tracings made on the kymograph. The top tracing was made after a period during which the subject used no tobacco. The middle one was made just after a smoke had been started. The lower one was made at the end of a long smoke.

A. How does the heart of a tobacco user seem to work just before he uses tobacco?

B. How does the heart of a tobacco user seem to work just after he uses some tobacco?

C. How does the heart of a tobacco user seem to act after he has been smoking or chewing a while?

3. **Review.** Recall or repeat the experiments with tobacco in Study Eight, Part One.

A. What is the particular narcotic substance that is found in tobacco?

B. What are three liquids in which this narcotic is soluble?

C. What is the effect of nicotine on insects and small animals?

4. **Curing the tobacco habit.** If a boy has been so unfortunate as to have acquired the tobacco-using habit in any form, he can use the recipe that follows, to help him break off easily.

Use a 10 per cent solution of silver nitrate, which can be prepared by any competent druggist. Apply this solution with a camel's hair brush to the tip and edge of the tongue every two or three days for two or three weeks Make these applications often enough to cause the loss of a desire to use tobacco. The combination, in the saliva, of silver with the products of tobacco results in a brassy taste.

Exercise III. Patent Medicines and Their Drugs

The following list of kinds of patent medicines may serve as the basis for classifying a collection of medicine bottles. Collect the bottles with labels still on, but have the bottles clean.

1. The "ethical preparations," to some extent beneficial.

2. Fraudulent but not injurious or dangerous "remedies."

A. The cures, if any, are mentally induced.

B. The use of the remedies usually serves only to delay proper treatment.

3. "Remedies" to some extent dangerous, but not inducing a drug habit.

A. Hair "restorers" containing sugar of lead.

B. Cosmetics containing corrosive sublimate.

C. Blood "purifiers" containing iodid of potassium.

D. Consumption "cures" containing chloroform.

4. Dangerous to life and usually inducing a drug habit.

A. "Remedies" whose chief element is alcohol.

B. "Remedies" containing opium and its derivatives.

- *a*. Forms: Pure opium, laudanum, paregoric, morphine.
- *b*. Examples: Soothing syrups and consumption "cures."

C. "Remedies" containing cocaine; for example, catarrh cures.

D. "Remedies" containing acetanilid, which is a powerful heart depressant. Acetanilid is used in practically all headache medicines.

Exercise IV. Questions for Investigation

1. What are theine and caffeine?
2. What is tannin?
3. Why are tea and coffee not good for you to drink?
4. If you have formed the habit of drinking tea or coffee, which have you been drinking, and how many cups do you take in a day?
5. Why is cocoa a more healthful beverage than tea or coffee?

6. Why is milk the most nourishing of all beverages?

7. What is the difference between grain alcohol and wood alcohol?

8. What is denatured alcohol?

9. What is the effect of alcohol on the general health?

10. What is the effect of alcohol on length of life?

11. What is the effect of alcohol on the structure of cells?

12. What is the effect of alcohol on the mind?

13. What is the effect of alcohol on muscle control?

14. Name some diseases caused by alcohol.

15. Why is, or is not, alcohol a food?

16. Who were the first people known to use tobacco?

17. Who is said to have started the practice of smoking among English-speaking peoples?

18. Why is the use of tobacco so widespread?

19. What is nicotine?

20. How does the use of tobacco affect body growth?

21. How does the use of tobacco affect the muscles?

22. How does the use of tobacco affect the nervous system?

23. How does the use of tobacco affect the mind?

24. Why should boys and girls not use tobacco?

25. Mention five other drugs besides nicotine that act as narcotics.

26. How much do Americans spend annually for tobacco? For cigars? For cigarettes? For public schools?

27. In order to keep up the business and make money for the tobacco companies, how many boys and girls every day, do you suppose, must learn to smoke a part of the sixty billions of cigarettes used in America annually?

28. What are some good habits to form with respect to stimulants, narcotics, and drugs?

STUDY THIRTY-FIVE

THE AIR AND BREATHING

You have had the experience of working somewhere in the midst of various noises, to most of which you paid no attention until one of them stopped sounding. In general, the things that are with us constantly we pay little or no attention to. So it is not strange that men gave little or no thought to the composition of the air up to a century and a half ago. Then, one of the interesting items of news that Benjamin Franklin must have read in the English newspapers was that Joseph Priestley had discovered oxygen. While you cannot conveniently repeat the experiments that Priestley performed when he first learned about oxygen and its presence in air, there is a simple experiment that you can easily perform, which will do as well for your purpose.

Exercise I. Studies of the Air and Its Constituents

1. **Finding the oxygen in air.** Fill a wash pan or other shallow vessel half full of water and on it float a flat cork that is about 2 inches across and ½ inch thick. Insert the wood end of a match in a small hole in the center of the cork so that the head of the match will ride about an inch above top of the cork.

Invert a good-sized water glass (the less sloping the sides the better), and hold it in one hand near the match head. With a lighted match, set fire to the floating match and instantly cover the floating cork and match with the glass. Let the rim of the inclosing glass rest close to the bottom of the pan. The white fumes from the burning match head are caused by the fact that the phosphorus in the match head eagerly takes up the

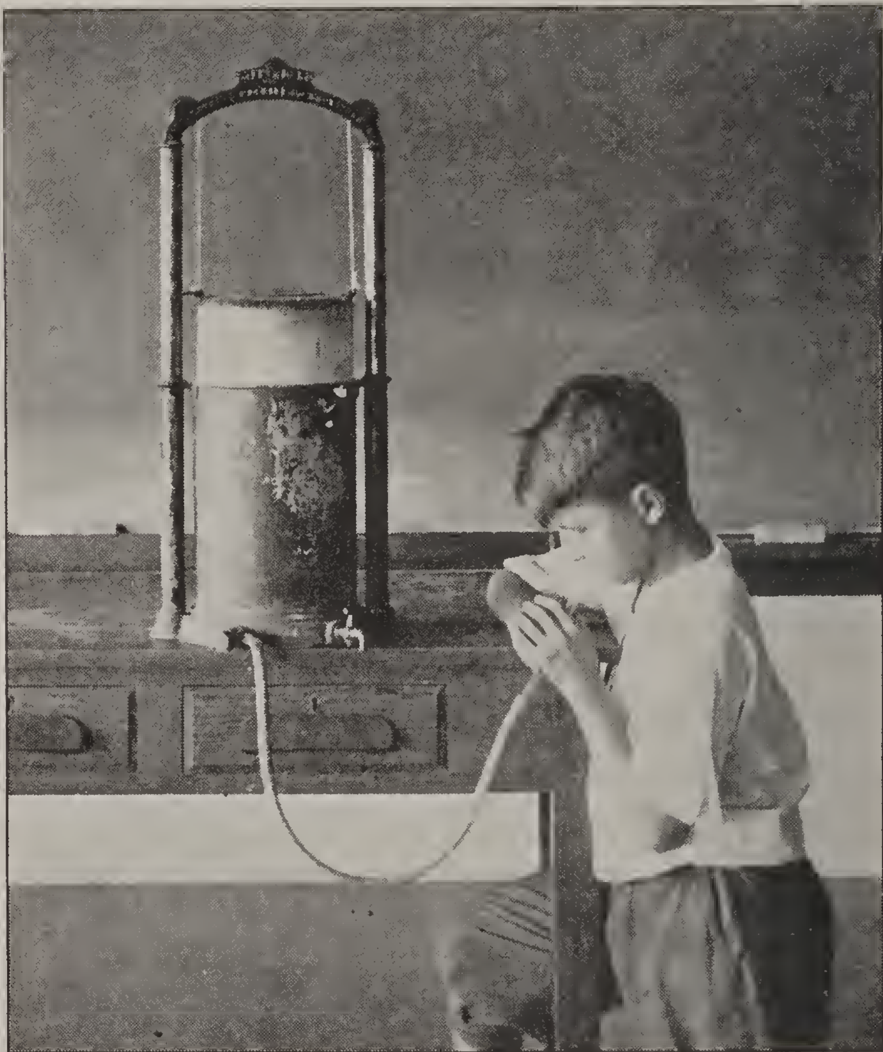

Fig. 57. The lung test. This spirometer is sold as a regular piece of laboratory equipment. The boy is using a sterilized glass mouthpiece, as he should do; but he might make a better record if he kept his chest clear of the table. (See also Figure 10.)

oxygen in the enclosed air and makes a white compound called *phosphorus pentoxid.* These white fumes quickly dissolve in the water, and thus the oxygen that was in the air is taken down into the water and the water from below comes up to take the place of the oxygen — the water level rises within your glass.

After the flame dies out, raise the glass until its rim is just under the surface of the water in the pan, cover the

mouth of the glass with a piece of cardboard or a piece of window glass by passing it under the water and pressing it snugly up against the rim of the inverted glass. Now turn the glass right side up, still keeping the lid closely on so as to retain the water that had flowed up into the cup. Estimate the fraction of oxygen found in ordinary air, basing your estimate on the quantity of water that took the place of the oxygen. Make some allowance for the fact that bubbles of the heated air escaped during the burning. What proportion of ordinary air consists of oxygen?

2. **Nitrogen in air.** Ordinary air is a mixture of several gases, that remaining in the cup after the burning being mainly a gas called *nitrogen.* Slip the cover off the glass of nitrogen and water, insert a burning match into the nitrogen, and see what happens. Replace the cover quickly. Why did the match go out?

3. **The effect of nitrogen on an insect.** Put a grasshopper or other insect under the cover and let it rest on the floating cork, putting the cover down tightly. At the same time put a similar insect in a similar glass with just as much water in it as there is in the first glass; but let the air in the second glass be fresh. Cover the second glass tightly. Watch both glasses for a few minutes.

A. Why does the insect in nitrogen gas keel over, while the one in ordinary air does not?

B. Take out the keeled-over insect and give it some fresh air. What happens when a partly smothered insect is given fresh air, and why is this so?

4. **The oxygen in exhaled air.** Repeat the first experiment in this study; but before covering the flame of the floating match, see that the glass is filled with air exhaled from your lungs. This air can be kept in the glass by

holding a cardboard over it until you are ready at once to cover the flame. Compare the water that came in this time with the quantity that was in the glass at the end of the first experiment. Keep the glass covered for later use. What evidence have you that exhaled air has less oxygen in it than inhaled air has?

5. **Testing for carbon dioxid.** Slake some fresh lime in a big bottle of clear rain water and let stand until there is clear limewater on top. Pour this clear limewater into a bottle by itself, letting none of the lime at the bottom carry over. Take two clean bottles, such as pint milk bottles, and put a teaspoonful of clear limewater into each of them. Now fill up one bottle with ordinary air and the other with exhaled air. Shake the bottles, and note the color of the water in each. A gas called *carbon dioxid* is the only ordinary gas that will turn limewater milky. What two things have you learned from mixing limewater with fresh air and with exhaled air?

6. **Testing the breath for carbon dioxid.** Take a small vial or test tube and put a little limewater in it. Now insert a glass tube and blow through it so as to make bubbles in the limewater.

A. What happens to the limewater when you blow your breath through, and why does this happen?

B. The addition of a large amount of carbon dioxid will dissolve the white particles that a small amount of carbon dioxid may have caused to form in limewater. Keep on blowing through the tube for a while. What is the result and what causes it?

7. **Amount of carbon dioxid in exhaled breath.** In the center of each of two saucers of water put a small piece of stick potassium hydroxid. The piece should be about as big as the last joint of your little finger. Over one sau-

cer invert a pint milk bottle with ordinary air in it, and over the other invert a similar pint milk bottle with exhaled air in it. Potassium hydroxid absorbs or takes

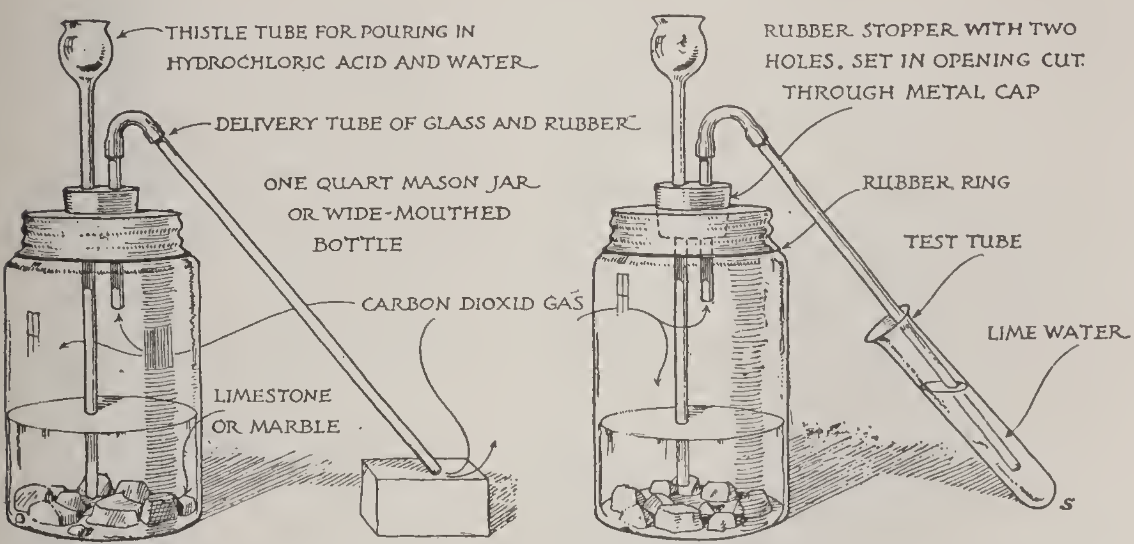

FIG. 58. Apparatus for generating carbon dioxid and for testing it.

up the carbon dioxid gas, and water comes into the bottle to take its place. What fraction of exhaled air is carbon dioxid, as you judge from your experiment with potassium hydroxid?

8. Experiments with carbon dioxid. Provide a carbon-dioxid generator such as is shown at the left of Figure 58, and perform the experiments called for.

A. Fill a test tube or bottle with carbon dioxid and put a stopper in it. What does carbon dioxid look like?

B. Take another test tube or bottle filled with ordinary air and into it slowly "pour" the contents of the bottle of carbon dioxid. Now add some limewater and shake. How do you know that carbon dioxid is heavier than air?

C. Fill one of two equal-sized bottles with carbon dioxid, and leave ordinary air in the other. Catch two

insects of the same kind, put one in each of these bottles, and then let the bottles stand for some minutes. To find out whether the insect in the carbon-dioxid bottle has been poisoned, or whether it is merely motionless from want of oxygen, take it out and keep it in fresh air for a while. Why does an insect keel over when confined in a bottle of carbon dioxid?

D. Would you judge from these experiments with insects that carbon dioxid is poisonous — that it is destructive of animal tissue?

E. If a man drowns, does he die because the water poisons him?

F. If a miner is overcome with choke damp, what causes him to lose consciousness?

9. The sources of carbon dioxid in nature. Prepare a carbon-dioxid tester from a quart Mason jar, as shown at the right in Figure 58. Have at hand also four additional Mason jars, each with its own lid. To test for the presence of carbon dioxid in ordinary air, pour a pint or more of water into your tester through its funnel, first making sure that the lid of your tester is screwed down tightly on a good rubber band. The water passing into the jar will force the air out through the delivery jet of clear limewater. If the limewater takes on the appearance of milky water, you may be sure that there is an appreciable amount of carbon dioxid enclosed in the air in the jar.

A. Does ordinary air have an appreciable amount of carbon dioxid in it?

B. Into a Mason jar, pour water to the depth of an inch, and then put a short leafy twig in the water, letting it stand on the broken end. Put the lid on loosely, and let the jar stand in a warm, dark place for a day and night. Test for carbon dioxid, as suggested above, by trans-

ferring the tester lid to the can with the leafy twig and screwing it down tightly. What evidence do you have

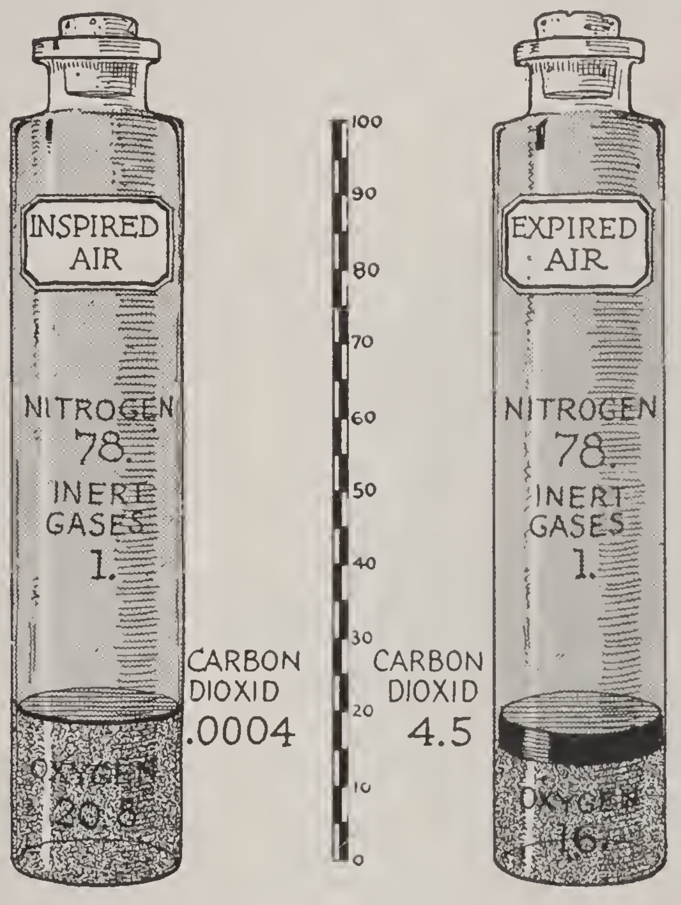

FIG. 59. The gas content of the air as our lungs receive it and as they throw it out. The percentage of nitrogen and other gases that our lungs do not act upon remains the same.

that leaves from a broken twig do or do not give off carbon dioxid?

C. Put pieces of decayed fruit in a second jar, place the lid on loosely, and let stand in a warm place. In 24 hours exchange can lids as before and test for carbon dioxid. Does decayed fruit give off carbon dioxid?

D. Put a handful of viable seeds (seeds that will grow), such as peas, beans, or corn, into a third jar, cover with

water, and put the lid on loosely. Keep the jar for a day and night in a warm, dark place; then test for carbon dioxid as before. Do germinating seeds give off carbon dioxid?

E. Into a fourth jar, put water an inch deep, then add a tablespoonful of molasses or brown sugar and half a cake of yeast well broken up. Cover loosely with a lid, and keep in a dark, warm place for 24 hours. Test for carbon dioxid. Does growing yeast give off carbon dioxid? Why is yeast put into dough? Why does dough have to be kneaded?

F. Name a half-dozen sources for the natural production of carbon dioxid.

10. **Why we breathe.** Study the diagram, Figure 59, and then answer the questions that follow.

A. What does the air gain and what does it lose when passing through the lungs?

B. What, therefore, seem to be the two important purposes of breathing?

Exercise II. Studies of Breathing

1. **Your three lung capacities.** You need now to measure your lung capacities. To do this it will be necessary to provide a lung tester or spirometer, such as is described on page 15 and illustrated in Figure 10. Note, as shown in Figure 60, that after taking in an ordinary breath (*tidal air*) you can still take in more air (*complemental air*). You should note further that after giving off an ordinary breath (*tidal air*) you can give off still more air (*supplemental air*). These three capacities make up what is known as your *vital capacity*. Even after expelling all the air you can, there are still about 100 cubic inches of air left in your lungs (*residual air*).

A. Fill the lungs as full as possible and then exhale into a lung tester or *spirometer* all you can. What do you find to be the volume of your *vital* capacity?

B. Just after taking in an ordinary breath, exhale into the spirometer all you can. What do you find to be the

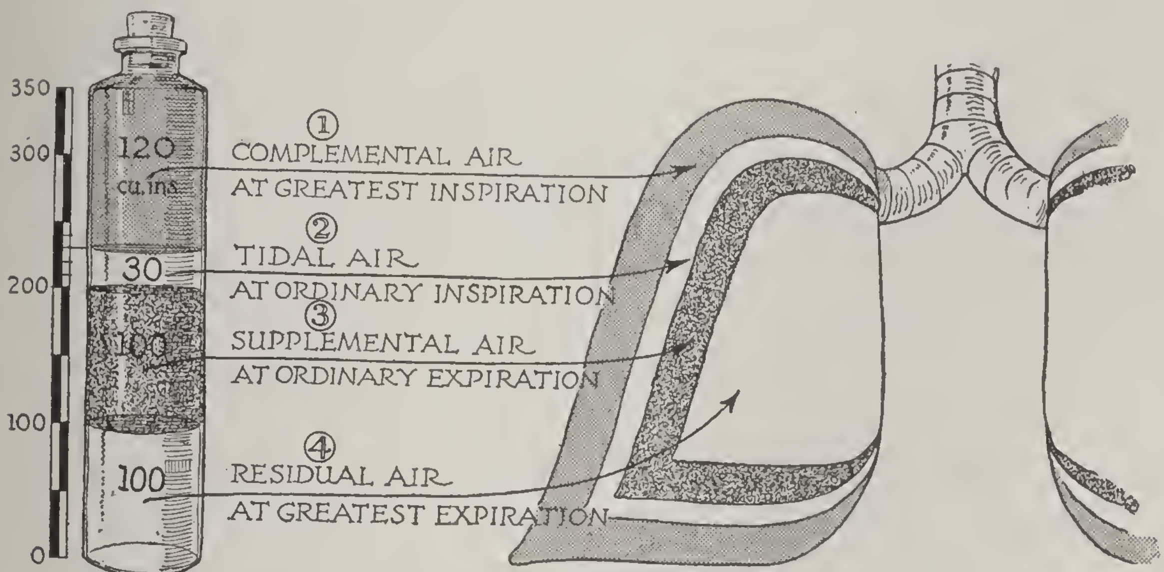

FIG. 60. Lung capacities at different stages of breathing. The figures apply to the normal adult, whose total lung capacity, as represented by the content of bottle, is about 350 cubic inches. For the average fifth grader, the figures given should be cut in two.

volume of your combined *tidal* and *supplemental* capacity?

C. Subtracting the above result from your vital capacity, what do you find to be your *complemental* capacity?

D. Just after *giving off* an ordinary breath, exhale into the spirometer as much air as you possibly can. What do you find to be the volume of your *supplemental* capacity?

E. Subtract the result for your supplemental capacity from the measurement taken in *B.* What do you find to be the volume of your *tidal* capacity?

2. **Finding your chest expansion.** Placing the tape line at the level of the lower end of your breastbone, take the

circumference of your chest when all the air possible has been expelled from the lungs. Take the measurement again when the lungs have been fully inflated. Find the difference between the two measurements. What is your chest expansion?

3. **How air gets into and out of the lungs.** Take a stopperless pint or quart bottle with the bottom broken out. Hold this bottle so that its base will be just under the surface of the water in a deep vessel. Place a burning match or candle at the bottle's mouth as you thrust the bottle farther down into the water and as you quietly bring it up again. What may it be that makes the air come into and go out of your lungs, judging from your experiment with the bottomless bottle?

4. **Abdominal breathing.** Draw your breath several times by using the muscles of only the lower half of the trunk (*diaphragm* and *abdominal* muscles, but not the *rib* muscles). See the fourth experiment in Study Four, Part One.

A. What is abdominal breathing?

B. Do men or do women use this kind of breathing the more?

5. **Chest breathing.** Breathe by using the muscles of only the upper half of the trunk (the rib muscles), inhaling and exhaling several times.

A. What is chest breathing?

B. Do men or do women use this the more?

6. **Mixed breathing.** Breathe now by using both methods.

A. What is mixed breathing?

B. What kind of breathing is best for people generally?

7. **Volume of air you breathe per hour.** By careful

observation, discover the number of times you ordinarily breathe in a minute. Multiply the number of cubic inches you ordinarily breathe (your *tidal* capacity) by the number of your breaths a minute, and then multiply this result by 60. How much air do you breathe in an hour?

Exercise III. General Questions

1. What is air composed of?
2. Why do you need air?
3. What would be the probable change in the size of people's lungs if the proportion of oxygen and nitrogen in the air were to be interchanged?
4. Why is carbon dioxid sometimes called "choke damp"?
5. What are some uses of carbon dioxid?
6. What are two purposes of breathing?
7. How do you get air into and out of your lungs?
8. What type of breathing do you mostly employ?
9. What are some things you could do to increase your lung capacity?
10. If your lung expansion is not at the standard for one of your height and weight, how much is it off, and in which direction?
11. Set down in your notebook some of the means by which you can be sure to get good air indoors.

STUDY THIRTY-SIX

RESPIRATION AND THE ORGANS OF RESPIRATION

WHY is it that you can hold your breath scarcely a minute, while the Red Sea pearl divers, without apparatus, can stay under water more than a minute — sometimes even more than 2 minutes? The reason is that these divers have had long practice in developing lung capacity. They take more air under the water with them than untrained men could, and that is the secret of their staying under longer. But why does one need air at all? What element of the air is directly useful? What becomes of the air that has been used? These and other questions constitute the problem of *respiration*, the process by which the body exchanges its carbon dioxid for oxygen.

EXERCISE I. STUDIES OF RESPIRATION

1. **Respiration in plants.** Invert one pint milk bottle over another pint milk bottle, the bottles being held together by a single large cork that projects into the mouth of each, as shown in Figure 61. After the cork is fitted, take it out and through the center of it bore a hole large enough to allow the stem of a young bean plant, or other plant, about four to six inches long, to pass through it loosely. You will have to split the cork halfway in to admit the stem of the bean plant. Set up your two bottles again. Now set up another pair of bottles in the same way, placing a second young bean plant within them.

A. Fill one of the under bottles with fresh well water, and fill the other under bottle with well water that has been boiled (to get rid of its oxygen) and cooled. Let stand for several days. Does a plant do better when

FIG. 61. These two bean plants were of the same general appearance at the beginning of the experiment; and they were treated alike, except that the water supplied to one of the plants contained extremely little air.

its roots are in water containing oxygen, or when its roots are in water containing no oxygen?

B. Toward the end of the experiment in *A*, set the bottles in a dark place for 24 hours. Then take the top bottles off carefully, set them right side up at once, and pour some clear limewater into each of the two. Quickly

cover the mouths of the bottles and shake the bottles, so as to mix the air and limewater. What gas did your bean plants give off at night, or in the dark, as you judge from the result of this experiment?

C. How did the bean plants in your experiments illustrate the process of respiration, that is, the process of giving off carbon dioxid and taking in oxygen?

2. **Respiration of fishes.** Put goldfish or other small fish in a gallon vessel of water that has been boiled and cooled.

A. In what part of a vessel of previously boiled water do fish tend to stay, and why do they stay there?

B. Transfer the fish to a similar vessel of fresh water that has not been boiled. Where do fish tend to stay in a vessel of fresh water, and why do they stay there?

C. Let the fish remain for a day or two in the vessel that contains the unboiled water. Where do the fish tend to stay in a vessel of water they have been in for a day or two, and why do they stay there?

3. **The needs of a candle flame.** Recalling or reproducing the experiment with the candles in the studies of air in Part One, Study Five, explain why a candle flame goes out if it is completely covered with a vessel.

4. **Need for oxygen in combustion.** Recall your experiments with the burning food and the calorimeter in Part Three, Study Thirty-three. What does food require in order to make it burn and yield heat?

5. **Human external respiration.** Study the diagram, Figure 62, and then answer the questions that follow:

A. What is the gain in the quantity of oxygen in the blood that passes through the lungs?

B. What is the fractional loss of carbon dioxid from the blood that passes through the lungs?

C. How much more carbon dioxid than oxygen is there in the blood, even as it goes *from* the lungs?

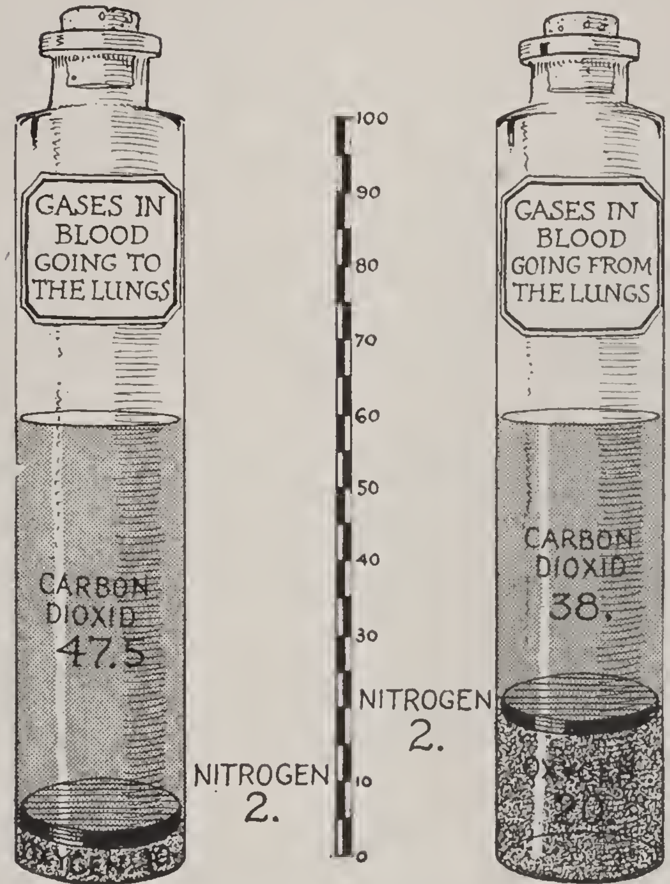

FIG. 62. The gas content of the blood as it enters the lungs and as it leaves them. As in Figure 59, it is only the percentage of carbon dioxid and the percentage of oxygen that are affected.

D. Carbon dioxid being an impurity in the blood, is it proper to say that blood is wholly purified in the lungs?

E. What, then, would be a truer statement about the work of the lungs?

EXERCISE II. YOUR BREATHING ORGANS

1. **Breathing through the nose.** Recall or repeat the studies of the nose and throat given in Part One, Study

Four. What are the six reasons why you should breathe through the nose?

2. **Studying a voice box.** Get from a butcher the voice box or *pharynx*, and a part of the windpipe or *trachea*, of a hog or other animal, and make an examination of it.

A. Does the lid of the larynx, called the *epiglottis*, open forward or backward?

B. Are the *vocal cords* like two fiddle strings? If not, how can they better be described?

C. How do you think an animal produces voice with its larynx?

3. **Studying a windpipe.** Examine the windpipe or trachea for answers to these questions:

A. What serves to keep the tracheal tube open for breathing?

B. Why can the tracheal tube be bent so easily?

C. Into what two tubes does the trachea divide at its lower or lung end?

4. **Studying lungs.** Examine the trachea, lungs, and heart of some animal, such as a chicken, hog, or sheep.

A. Why do butchers sometimes call the lungs of an animal the "lights"? (See this term in the large dictionary.)

B. Why do the lungs of an animal float when thrown in water?

C. Thrust into the trachea a glass tube of a diameter that will fit snugly into the tracheal opening. After taking in a full breath, blow the prepared lungs as full as possible. How much bigger are a pair of lungs when inflated than when not inflated?

D. Now cut off a lobe of the lung and examine the interior of it. If a lung is neither hollow nor solid on the inside, how would you describe it?

E. If you find little cartilaginous tubes (branches of a bronchial tube) running through the inner parts of a lung, what purpose do you think they serve?

5. An artificial thorax. Arrange a device such as the one shown in Figure 63, using a cylindrical lamp chimney, a long flat cork with a small hole in it, a short glass tube, a small rubber balloon, or "squawk," and a piece of flat rubber dam such as dentists use.

A. What breathing organ does each of the parts represent, as shown in the accompanying diagram? Copy Figure 63 in your notebook and label the parts of the apparatus with the names of the breathing organs.

B. How, with the rubber base representing the *diaphragm*, can you get air into and out of the rubber squawk, representing a *lung?*

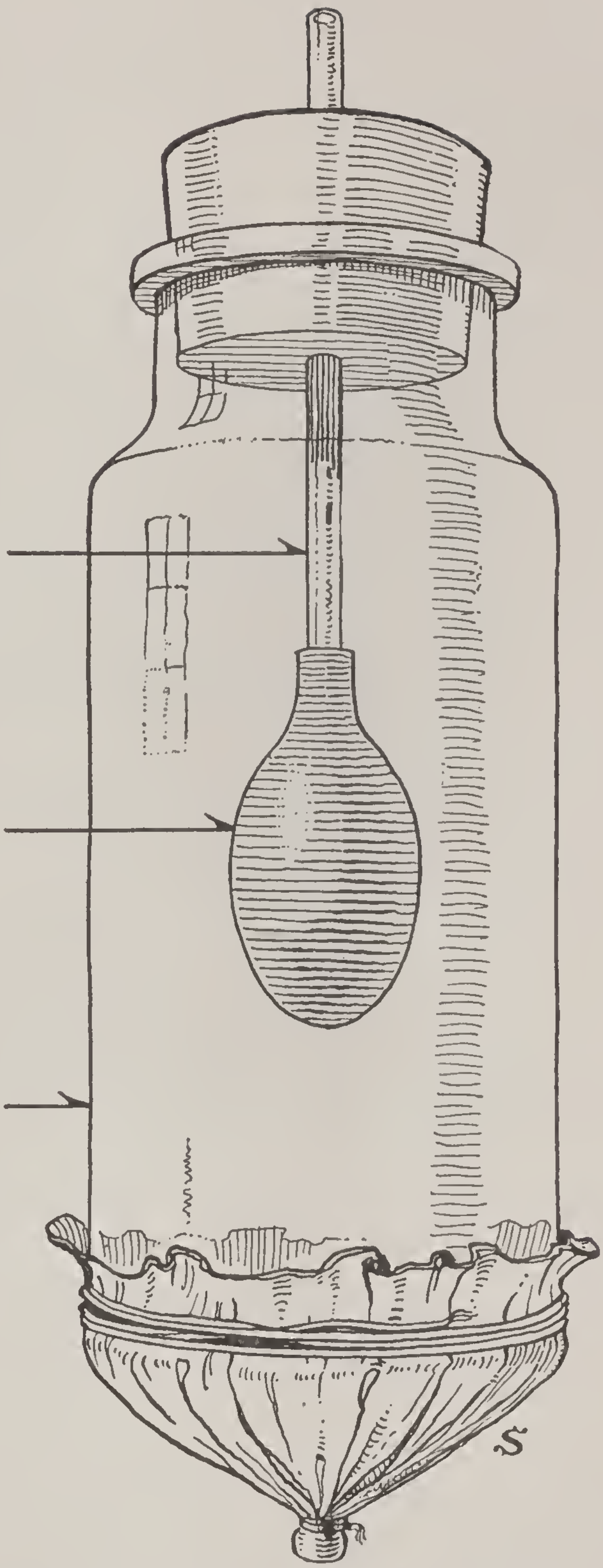

FIG. 63. Apparatus for demonstrating how the lungs work.

Exercise III. Questions for Investigation

1. What is respiration?
2. What are the two objects of respiration?
3. In taking in a breath, through what successive organs of respiration does the air pass?
4. What is the thorax, and what is it for?
5. What is the diaphragm, and what is it for?
6. How are the ribs used in breathing?
7. What organs does the thorax contain?
8. What becomes of some of the oxygen that goes into the lungs with the air?
9. Where does the carbon dioxid come from that is found in the air passing out of the lungs?
10. Why should you be careful not to get dust into your lungs?
11. Why should the nose be the place for the sense of smell?
12. What is the effect of tobacco smoke on the breathing organs?
13. In the light of the studies you have just made, what health habits do you think you should observe regarding respiration?

STUDY THIRTY-SEVEN

BLOOD AND LYMPH

EXAMINED with the unaided eye, blood appears to be a rather thick, red liquid of uniform substance. Such a liquid the ancients supposed it to be, because they had no instruments with which to make a minute examination. They realized that it is a vital fluid, but they had no means of discovering how it served its important purposes.

It was not until the settlement of the American Colonies was well under way that a Dutch scientist, named Leeuwenhoek, made use of the microscope to study human blood. Great must have been his astonishment when he discovered that blood is about half water, and that myriads of tiny circular bodies (corpuscles) float in this water. The sight that was so strange in Leeuwenhoek's day we may now see with very little difficulty.

EXERCISE I. WHAT BLOOD IS MADE OF

1. **Appearance of blood highly magnified.** Place on a glass slide a drop no bigger than a pinhead of normal salt solution (water and .6 per cent. of common salt). With a handkerchief wrap one of the fingers of the left hand from the knuckle down to the first joint. Bend the joint and with a needle give it a sharp prick near the root of the nail. The needle should have been sterilized by dipping it in alcohol or holding it for an instant in a hot flame. Touch the drop of blood you have just secured, to the salt solution on the slide. Quickly apply a clean cover glass, pressing it down with the back of a finger nail, so as to keep the cover glass free from finger marks. Press until there is only a thin layer of blood under the cover

glass, so thin as to appear more orange than red. Place the mounting in a compound microscope as shown in Figure 65. Examine the mounting under the lenses that magnify about 100 diameters.

What is the appearance of blood when seen under a microscope?

2. **Blood magnified 500 times.** Taking the slide used in the foregoing experiment, while the blood is still fresh, examine for *red corpuscles.* Use the high-power microscope, magnifying 500 times. These red corpuscles are the numerous bodies only slightly tinged with color, that float around in a liquid called *plasma.* The red corpuscles are all of the same size and shape, though they may not appear so, for they are biconcave discs; that is, they are shaped as some peppermint candy discs are — considerably hollowed out at the center on both sides, but without a hole through the center. Make drawings of as many shapes as appear, and as nearly as possible show relative sizes. Note that a human red corpuscle does not have a nucleus. If the mounting stands too long, the red corpuscles tend to get star-shaped. A new mounting will then have to be made, if further examination is needed. The red corpuscles carry the oxygen over the body. What is the appearance of a red blood corpuscle when seen under the microscope? (See Figure 21.)

3. **Seeing white corpuscles.** Looking very sharply you may see one or two colorless or gray corpuscles that are irregular in shape, and granular in appearance. These are white corpuscles, the kind that fight germs. There is only one to three or four hundred red ones. What is the appearance of a white blood corpuscle when seen under a microscope?

4. **The clotting of blood.** To examine blood in larger

quantities, some fresh blood will be needed. The blood of a chicken that has just been killed will serve very well. The blood should be collected in a suitable bottle just before it is needed by the class. At once divide the quantity of blood into three equal parts, pouring it into three small, wide-mouthed bottles. Set one of these bottles away in a warm place. Into the second bottle put about one-tenth as much of a saturated water solution of epsom salts as there is blood. With a common table fork stir constantly the blood in the third bottle, occasionally wiping off the threads of fibrin that gather on it. The stirring should continue until the threads quit forming. What makes blood clot?

5. **Studying clotted blood.** After the blood is clotted in the first bottle, note how the jellylike part draws up in the center of the bottle and permits a liquid to gather around the outside. This liquid is called *serum.*

A. Recalling how the fibrin threads that formed in the plasma in the third bottle were taken out on the fork, what would you say is the difference between serum and plasma?

B. Why did not the blood coagulate in the bottle that had the epsom salts in it?

C. How do you suppose mosquitoes manage to keep the blood from clotting around their bills when they pierce the skin of an animal and suck blood for some minutes at a time?

D. What is the advantage of the clotting of blood when a wound is received?

6. **The chemical nature of blood plasma.** Recalling that litmus paper turns red when it is put into an acid solution and blue when it is put into an alkaline solution, test with pieces of blue and pink litmus paper some of the blood serum from your prior experiments.

FIG. 64. A frog properly mounted so that the flow of blood through its web may be observed. The mounting should be done carefully and humanely, and the cloth should be moist or even wet. A frog drinks through its skin.

Now test the plasma for grape sugar, using the test for grape sugar given in Study Thirty-one, Exercise I.

A. Is blood acid, or alkaline, or neutral?

B. What evidence have you that there is no grape sugar in the blood?

7. The work of red corpuscles. Take a glass tube and exhale air through it into the blood of the second and third bottles.

A. What change in color takes place in blood when exhaled air passes through it?

B. Since the exhaled breath is deficient in oxygen, why did the blood change color as it did?

8. The work of white corpuscles. Turn to Study Seventeen, Exercise II, and perform the experiments and answer the questions there given, if you have not already done so. If you have previously performed the experi-

ments, reread the Exercise, and then answer these questions:

A. How do white corpuscles fight germs?

B. Under what condition will white corpuscles destroy germs at all?

C. What is an opsonin?

D. What is an antitoxin?

Exercise II. What Lymph Is

For this study you will need a live frog of medium size, such as any boy or girl can capture. The study will give you a chance to get a glimpse of some very small blood

Fig. 65. A compound microscope in use for studying the circulation of blood. Six different magnifications may be made with this instrument by shifts of the lenses. The frog should be allowed to hop away as soon as he has made his contribution to education.

vessels and also the blood and lymph as it appears in the web of a frog's foot.

1. **A frog's web under a microscope.** Provide a thin board or shingle about 3 by 8 inches in size. At one end of this board make a hole an inch in diameter, and cover this hole with a piece of glass held in place by four tacks. Wrap a live frog gently with a damp cloth so as to keep its skin at all times well moistened. Leave one hind leg of the frog free, and mount the frog on the board as shown in Figure 64. When mounted, the web of the uncovered foot should lie on the glass over the hole and be held in place by soft threads tied to two of the frog's toes and then fastened to the end of the board in a way to stretch the web gently.

Lay the web end of the frog mounting on the stage of the microscope, and so hold the other end that the web will come level under the object lens, as shown in Figure 65. Now, using the lenses that magnify about 100 diameters, study the numerous little streams of blood, with their floating corpuscles, running in various channels through the field. These channels are small blood vessels. The branched black spots in the field are pigment granules in the skin of the frog. Remember that the rate at which the blood is seen flowing is magnified also. The blood, therefore, really flows only one one-hundredth as fast as it seems to flow.

Draw a part of the microscopic field showing the three kinds of blood vessels in a frog's web, and label each properly.

2. **The appearance of lymph.** In the observations just made, the corpuscles were seen floating in the liquid called the *plasma*. Look at the same mounting again and note that in the thin parts of the flesh outside the blood vessels

there is a liquid among the cells of the tissue. This liquid is called *lymph*, and it got where it is by oozing out through the very thin walls of the finest blood vessels. Lymph, therefore, does not generally differ much from blood plasma. However, it is present in every part of the body outside the blood channels and where there are cells. Which of the liquids of the body do you suppose is the greater in quantity, the plasma or the lymph, as you judge from what you see in the frog's web?

Note. When through with the observation called for, carefully release the frog and return it to the place where you got it. It should not have suffered if you followed directions carefully.

3. **Lymph as commonly seen.** In a water blister, you have had a chance to observe real lymph.

A. What is lymph like, as you see it in a water blister?

B. In what way are tears and sweat somewhat like the liquid that comes from a water blister?

Exercise III. General Questions

1. What are the parts of the blood?
2. What is the plasma made of?
3. What makes the blood look red?
4. What is the shape of a red corpuscle?
5. What is the work of the red corpuscle?
6. How do white corpuscles differ from red ones?
7. What is the work of white corpuscles?
8. What are the capillaries?
9. What is lymph, and what is it for?
10. Where does lymph come from?
11. How does lymph get back into general circulation?
12. What health habits have been suggested to you by your studies of blood and lymph; that is, what habits do you think would help you to keep up a good quality of blood?

STUDY THIRTY-EIGHT

THE CIRCULATION OF BLOOD AND LYMPH

William Harvey, an English physician, is known as the discoverer of the circulation of blood in the human body. He never saw the blood in actual circulation, except as he observed blood flowing from wounds. However, he judged from what he discovered about blood vessels and about the behavior of blood in the body, that it must circulate. Dr. Harvey died in 1657, but it was a few years after this that the microscope was so far perfected that it could be used to observe the finer blood vessels and the blood in actual circulation in animal tissue. What would Dr. Harvey not have given to be privileged to see a sight that modern science and invention have made easily possible for all!

Exercise I. The Blood Vessels

1. **Blood vessels in a frog's web.** Mount a frog as you did in Study Thirty-seven, and make a closer examination of the blood vessels. The very finest blood streams are in tiny blood tubes called blood *capillaries*. Look now for two of the largest blood vessels in the microscopic field. In one the blood will be seen flowing more swiftly than in the other, and in an opposite direction. The first of these blood vessels is called an *artery*, and the second is called a *vein*.

A. Which kind of blood vessel seems *under a microscope* to be carrying the blood *toward* the heart and which *from* it?

B. A compound microscope reverses its images both right and left and up and down. These streams are therefore really flowing opposite to their seeming direction. In

terms of the direction in which the blood actually flows in relation to the heart, what is a definition for an *artery* and what for a *vein?*

C. One of these two kinds of vessels divides and sends the blood into smaller tubes or *capillaries*, and the other receives its blood from smaller vessels. Which kind of blood vessel, an artery or a vein, empties its blood into larger vessels and which empties into smaller ones?

2. **The heart.** For your next study you need the heart of a hog, sheep, or other mammal. If you get this from a butcher, be sure to ask for a heart with the "pipes" left as long as possible on it, for otherwise he is likely to cut off these arteries and veins close down to the heart. The arteries stand partly open when empty, and the veins flatten down. Find the largest stump of artery there is, called the *aorta*, and the largest veins, called the *venae cavae*, and examine these. Then answer the questions that follow.

A. Which has the thicker wall, an artery or a vein?

B. Which is straw-colored and which is somewhat transparent?

3. **Examining your own veins.** Look at your wrist and note the blue lines showing the locations of veins. These are blue because the walls of the veins make them look so. The blood in them is not blue but dark red. Now lay your finger across the veins in the wrist, and press the blood first toward the palm of the hand and then toward the elbow. Which way do you think the blood is naturally flowing in the veins you can see on your wrist?

4. **Taking your pulse.** To study your pulse, lay the back of your left wrist in the palm of your right hand, bringing the ends of your second and third fingers around until they press over the artery lying deeper than

the veins, and just inside the left bone of the left forearm. What is your pulse rate per minute under the various conditions set out below?

A. After sitting quietly for 10 minutes.

B. After standing up for some minutes.

C. Just after running rapidly for a few minutes.

D. How many pulse beats per minute has a baby?

E. How many pulse beats per minute has an old man or woman?

5. Locating other pulses. Locate six different places over your body where pulse beats can be counted in arteries. Where do you find six such pulsating places over the body?

6. Time relation of pulses. Sit with one knee over the other, allowing the upper leg to hang freely from the knee so as to give the foot a chance to bob with pulsations of blood sent out by the heart. Place the fingers of one hand over the big artery in the neck on either side of the voice box. At which point does the pulse beat seem to come first, at foot or neck? Why should it come there first?

7. Time relation of heartbeat and pulse. With the ends of the right-hand fingers placed over the space between the fifth and sixth ribs at a point about two inches to the left of the lower end of the breastbone, locate the "apex beat" of the heart. With the right hand still in position, place the finger ends of the left hand on the pulse in the wrist of the right arm. Keep this position until you feel a distinct beat through each set of fingers.

A. Does the apex beat of the heart, or does the wrist beat come first?

B. What do you infer is the relation between heartbeat and pulse beat?

EXERCISE II. THE HEART AND ITS WORK

1. **The inside of the heart.** Take the specimen of heart used in the second experiment in Exercise I of this Study, and cut its chambers open.

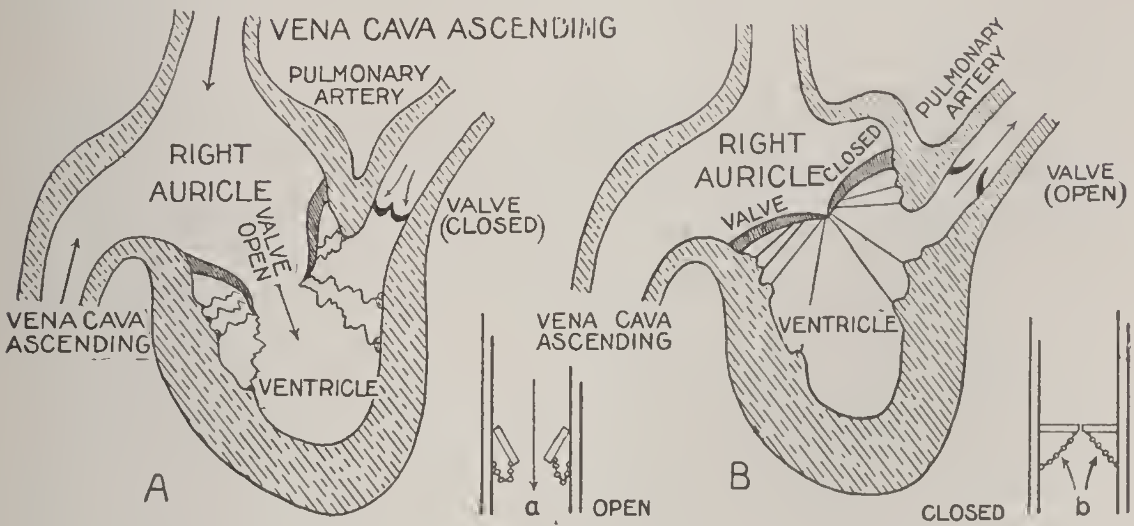

FIG. 66. Diagrams of the heart. *A* shows the action of the valves at the expansion of the heart. *B* shows the action of the valves at the beginning of contraction. The action of valves between auricle and ventricle is indicated in the diagrams of working models, *a* and *b*.

A. How many chambers has the heart you have studied?

B. What are the valves like that are between each upper chamber and its corresponding lower one?

C. Find the three little moonlike valves at the place where the aorta leaves the biggest chamber of the heart.

D. Do the valves in the aorta, where it joins the heart, let the blood go *to* or *from* the heart chamber?

E. How do they keep the blood from flowing the other way?

2. **Locating your own heart.** Locate the lower end of your breastbone and then move the finger ends an inch or two to the left until you come between the ends of the

fifth and sixth ribs and can feel the thumping of the lower point of the heart against the chest wall. This is the extreme left of the heart, the heart lying like an inverted pear, the big end of it being tilted over so it lies behind the lower two thirds of the breastbone. About how many inches is it from the upper edge of your heart to the lower edge?

3. **Studying heart sounds.** Place your ear against the central part of the heart of some other person. Listen closely for the two sounds the heart makes each time it contracts. Which sound of the heart is short and sharp and which is longer and duller, the first or the second?

4. **How the heart works.** If possible, get a glass model of a pump, such as can sometimes be found in a physics laboratory. If this cannot be done, perhaps a small pitcher pump can be examined to show how a pump's valves keep water going in one direction only. Make a drawing in your notebook showing what a pump valve looks like and how it works.

5. **The course of circulation.** The left side of the heart pumps blood out over the body through arteries, next through capillaries, and then through veins. These in turn bring the blood back to the right side of the heart. From this point it is pumped through the lungs back to the left side of the heart. If the heart is not strong, it cannot send enough blood to the lungs to get oxygen to distribute over the body. Why do some people feel "short of breath," as they call it, after climbing long stairways or running for a little distance?

6. **An artificial pulse.** Attach about two feet of narrow rubber tubing to the outgoing end of an ordinary syringe bulb. To the outer end of this long tube attach a glass nozzle that tapers down to a fine point or opening.

Put the receiving and the discharging ends of this apparatus into a pan of water, and cover the middle part of the long tube with a cloth or towel. Now set the bulb in action and put your fingers on the cloth over the tube as the waves of water are made to pass through the tube. By varying the action of the bulb, can you imitate a *strong* pulse, a *weak* pulse, a *sharp* pulse, a *dull* pulse? Just how do you squeeze the bulb so as to instate a strong pulse? A weak pulse? A sharp pulse? A dull pulse?

7. The lack of pulse in veins. Press down on the middle part of the rubber tube so as to let only a very small amount of water pass through.

A. In which part of the tube is there now a pulselike action?

B. Why does not the other part have a pulselike action? Explain fully why there is no pulse in veins.

8. Elastic and hardened arteries. Keeping exact account of the time it takes to do it, drive the water through the tube by strong, regular pulse strokes until you have filled a tumbler at the discharging end. Now take off the long rubber tube and replace it with a glass tube of similar diameter and length. Attach the glass nozzle of the rubber tube to the outer end of the long glass tube by a suitable rubber tube. Again timing the process, fill the glass and note the difference in effort and time.

A. How much longer did it take to fill a glass with water pumped through a glass tube; and which was the harder work, pumping through the glass tube or through the rubber tube?

B. Why was it harder to pump through the one tube than through the other tube of the same size?

C. Why does one who has "hardening of the arteries" also have high blood pressure?

9. **Review.** For further experiments on circulation, see Part One, Study Eight.

EXERCISE III. QUESTIONS FOR INVESTIGATION

1. Why does blood have to be kept circulating through your body?

2. What is the work of your heart?

3. What are the names of the cavities in your heart?

4. How does the blood get from the arteries over to the veins?

5. What are the capillaries for, besides connecting arteries with veins; that is, what is the special business of capillaries?

6. Through what successive vessels would a drop of blood pass in going from the left auricle around to the right auricle?

7. Through what vessels would a drop of blood have to pass in getting from the right ventricle around to the left ventricle?

8. What is "hardening of the arteries" and what are some of its causes?

9. How do disease germs sometimes affect the heart?

10. How does too much exercise sometimes injure the heart?

11. What exercise is proper for the heart, and what is improper?

12. How does tobacco injure the heart?

13. How do headache remedies affect the heart?

14. How do alcoholic patent medicines affect the heart?

15. How may the heart sometimes suffer irritation from the stomach?

16. What health habits would favor good circulation and heart action?

STUDY THIRTY-NINE

COMMON COLDS AND HOW TO AVOID THEM

COLDS are very common ailments, and they probably get their name from the fact that they so often develop after people get chilled. However, colds are really due to two conditions other than chilling. One of these is a disturbed circulation. There are some interesting facts about blood circulation that people do not commonly take into account in connection with colds; but by the use of apparatus such as is shown in Figure 67 these facts can be made clear.

The apparatus requires the use of a carpenter's saw-horse and a balancing plank about 6 feet long and about 12 inches wide. To the underside of each edge of the balancing plank and crossing its middle, fasten flat

FIG. 67. Apparatus for studying the effect of cold on the distribution of blood in the body. An old door has been used for the teeter board, and a big rock furnishes the weight.

pieces of iron and across their centers file a broad notch that will be just under the central cross line of the plank. Then on the top of the sawhorse fasten down two large three-cornered files or other objects that will form knife-like edges to support the balancing plank. When the plank is in position, suspend under it a box by wires from each corner of the board, and fill the box with bricks or iron enough to bring the center of gravity just below the centers of support when a pupil lies on the board.

Exercise I. Making Some Experiments with Blood Circulation

1. **The effect of cold on the distribution of blood.** When the apparatus described above is set up out of doors on a cold day and is ready for use, you must first let a healthy boy who does not easily catch cold, balance himself on it as shown in Figure 67, just after he has come out of a warm room. Fasten a block on the plank against the head and against the feet of the boy, to mark the exact place where he lay when warm. If necessary, secure any final balancing by the addition of small weights at either end of the plank. At best, there will be a slight teetering due to breathing, the muscles of breathing thrusting the abdominal contents back and forth somewhat.

When the apparatus has been balanced satisfactorily, let the pupil lie on the plank until he begins to feel rather cold. If the apparatus meanwhile gets out of balance, use a spring hand scale to pull it into balance, at the end of the experiment, placing the hook on one side of the board at the point just opposite the center of the breastbone of the pupil. Note the reading of the scale when the board is just brought into balance.

A. According to this reading, how many ounces of blood have passed upward from the lower limbs?

B. Find from your dictionary the meaning of the word *congestion* and write it in your notebook.

2. **Five kinds of congestion.** As a background for the understanding of colds we need to know the difference between what is called *active* congestion and what is called *passive* congestion. To demonstrate active congestion, take an ordinary syringe bulb and pump it very fast and see how the delivery tube becomes congested. To demonstrate passive congestion, pump slowly, but narrow the outlet of the delivery tube by pinching it down to a very small opening near the end. In active congestion the blood is driven by the heart into the congested part of the body. In passive congestion the blood is massed in the congested region because the outlets in that part have been somewhat stopped up.

A. What kind of congestion is blushing?

B. What kind of congestion comes when you have tied a string rather tightly around your finger?

3. **Active congestion.** Cold drafts or chilling are the means by which active internal congestion is ordinarily set up in the human body. As the second necessary condition for colds, germs must be present in the breathing passages. The congestion of blood, straining the capillaries in the air passages, now brings a lot of white corpuscles to the surface of the passages. These white corpuscles set to devouring the many germs; and accumulated dead corpuscles compose, in good part, the matter that stuffs your nose up when you have a cold in the head. To counteract this sort of cold, you need to have your system trained to throw back the blood to the surface from the inner parts of the trunk.

A. What is the effect on the training of the heart to counteract congestion, of cold baths in the morning, of exercise, of open-air sleeping, and of exposure to varying temperatures through the day?

B. If your face gets red when you are out in the cold in the winter time, how does this show that your heart is well trained?

C. What is the advantage of having abundant blood sent to the face in such a case?

4. Passive congestion. Passive congestion in the human body is caused by an unusual accumulation of germs along the air passages. As the white corpuscles now travel out to devour the germs, they impede the flow of blood in capillaries, and secure a congestion of blood in a passive way. Presently a condition results like that described in the preceding paragraph.

A. Why may you catch a cold if you frequent badly ventilated and crowded halls or rooms?

B. How is the continuous breathing of air that is *warm* and *dry* likely to affect the lining of the air passages?

C. What would be likely to happen at such a time if one were exposed to germs of cold?

D. Why are people whose noses are somewhat stopped up with adenoids or irregular bones, more liable to colds than other people?

E. How is it that if one works in a very dusty place, as around a threshing machine, he is particularly liable to catch a cold in the head?

5. Inflammation. If you have had a boil or other sore spot, try to recall whether that spot was warmer than the surrounding parts. Consider whether the spot was puffed out or swollen and was redder than usual. Such a congestion of blood is called an *inflammation*. Carefully

note both the spelling and the pronunciation of the word.

A. What are the four marks or characteristics of an inflammation?

B. Remembering that inflammations are generally due to the presence of germs, why should a good deal of blood be brought to the infected spot?

C. Why is "catching cold" a good deal like "getting" boils?

Exercise II. Questions for Investigation

1. What are epidemic colds and chronic colds?

2. Why are a warm bath and sweating beneficial in case of a cold, if care is taken to avoid any chilling?

3. Why will spraying the nose with an antiseptic help to prevent colds?

4. Why should you see to it that your upper air passages are kept free and open?

5. Why will the inhaling of cold air, the skin being kept warm, help to prevent colds?

6. How will the regular practice of keeping the bowels open help to prevent colds?

7. How will the regular taking of cold baths help to prevent colds?

8. Why should you train yourself to endure drafts of air that are not too cold or too strong or too long continued?

9. What is catarrh?

10. What is bronchitis?

11. What are some diseases that may follow neglected colds?

12. What habits must you practise so as to keep from catching colds easily?

STUDY FORTY

THE SKIN AND BATHING: CLOTHING

"CLOTHING makes the man" is an old saying that has enough truth in it to give it some point. Likewise, it is at least a half truth that a wholesome and attractive skin makes the individual. Certainly the skin proclaims the individual in more than one way. It is said that Helen Keller, the blind and deaf genius, is able to recognize her acquaintances accurately without touching or seeing or hearing them, and sometimes even without sensing the peculiar jar of their footsteps. You may guess how she does it.

EXERCISE I. THE SKIN

1. **Thickness.** Pinch up a fold of skin on the back of the hand and decide how thick you think the skin is at that place. Record this judgment in your notebook.

2. **Microscopic appearance.** Examine the back of your hand with a hand lens, which is also known as a "simple microscope." Next, examine the palm of the hand with the lens.

A. What does the skin on the back of your hand look like?

B. How does the skin on the palm of the hand differ in appearance from that on the back of the hand?

3. **Sweat pores.** Using a simple microscope again, look at the palm of the hand when it is a bit sweaty. Hold the hand in a strong light while making the examination. If you look very sharply, you should see little glistening spots along the top of one of the ridges and about as far apart as the ridge is wide. What makes the little glistening spots?

FIG. 68. At the "swimmin' hole." These schoolgirls are combining bathing and recreation; and, under safe conditions, they are learning to swim.

4. **Scar tissue.** Examine a scar on the skin somewhere. In what three ways is scar tissue different from true skin?

5. **Thumb prints.** After pressing the thumb of the right hand down on an ink pad such as is used in printing with rubber type, make a print of the face of the upper half of the thumb in your notebook. Get several of your classmates to make prints there also, until there is a complete row across the page. What use is made of finger prints, and why are they so reliable for their purpose?

EXERCISE II. USES OF THE SKIN

1. **Protection.** The outer layer of the skin we found to be made up of a dead layer of horny cells.

A. What purpose can the horny layer of the skin serve with respect to germs?

B. Of what value is skin with respect to the lymph under it?

2. **Seat of sensations.** The skin contains the nerve structures for four kinds of sensations. What are these sensations?

3. **Absorption.** If you rub some liniment on the skin, a very little bit of it may get through. What slight use may the skin serve if medicines are rubbed on it?

4. **Respiration.** The surface that is thrown open to air inside one of your lungs is more than fifty times as great as the surface of your skin. How much of your respiration may go on through the skin?

5. **Regulation of body temperatures.** One of the very important functions of the skin, as will be made clear later, is helping to keep the temperature of the body at 98.6° Fahrenheit. What are five different uses of the skin, counting the skin sensations as only one use?

Exercise III. Bathing and the Need for It

Recall or repeat the work of Study Nine in Part One.

Exercise IV. Caring for Finger Nails and Hair

Recall or perform the work of Study Ten.

Exercise V. Clothing in Relation to the Skin

Recall or repeat the work of Study Eleven.

Exercise VI. General Questions

1. Why is the surface of the body such a favorable place for the germs of decay to multiply? See Study Fifteen, Exercise II.

2. What is the primary reason why you should bathe?

3. How often, therefore, should you bathe?

4. What kind of bath will open the sweat pores of the skin; that is, start perspiration?

5. Will these pores remain open after you quit perspiring?

6. What kind of bath will close the sweat pores of the skin; that is, stop perspiration?

7. After you go where it is warm or after you begin to exercise, will the pores remain open?

8. What really opens and closes the pores of the skin — the temperature or the bathing?

9. What is the effect of a cold bath on the distribution of blood?

10. What is the effect of a warm bath on the distribution of blood?

11. What is the effect of a lukewarm bath on the distribution of blood?

12. At what time of day may you best take a daily bath, if you do not work amid dirty surroundings? If you do work amid dirty surroundings?

13. What is the primary reason for wearing clothing?

14. What are three uses of underclothing?

15. What are four reasons why mesh-woven cotton is better for underclothing than wool?

16. Why should you put on extra wraps when out of doors on a cold day?

17. Why should you take off these extra wraps and overshoes in the house, or where it is dry and warm?

18. What should be the general shape of shoes?

19. What are two serious objections to high-heeled shoes?

20. What are some habits that will help to keep the skin in the best of condition at all times?

STUDY FORTY-ONE

VENTILATION AND BODY HEAT

THERE is a widespread notion that we need fresh air in a living room primarily for breathing purposes. This idea, like a great many other ideas regarding the work and the needs of the human body, is only partly true. There are two other even more important reasons why a living-room ordinarily needs to be ventilated, and our present Study will attempt to make them clear.

EXERCISE I. GAINING AND LOSING HEAT

1. **Heat production in the body.** Put some drops of sulfuric acid in a small glass of water. Being exceedingly careful not to let more than a few drops go in at a time, keep on adding drops slowly until you feel the glass getting distinctly warm. There is a *chemical action* going on between the sulfuric acid and the water. Always where there is chemical action, heat is produced. This kind of action goes on in the muscles and glands of the body, and especially in the liver.

A. Why does the blood get warmed in the liver to the highest temperature anywhere in the body (107°F.)?

B. Why do contracting muscles get warm?

C. Why do you need so much more oxygen when you exercise vigorously?

D. Why do you get so warm when you exercise violently?

E. Why do you need more cover or clothing to keep you warm when lying down than you do when standing up or actively working?

F. Where is the heat produced in your body when you are asleep?

2. Conduction, convection, and radiation of heat. Heat is lost and gained directly from and to the body by three different processes. One of these processes of heat transfer is illustrated in the case of holding one end of a stove poker in the fire till the handle gets hot. The heat here travels from one tiny particle of iron to the next one, and so on. The process by which heat travels over the successive particles of a substance is called *conduction*.

The second of these processes of heat transfer is called *convection*. This is the process that goes on when a pan of water is heated over a flame. The particles of water nearest the source of heat are made hot. These heated particles rise to the top, while the colder particles fall to the bottom of the pan, where they become hot. By a circulation of particles, the mass becomes heated. This method of heat transfer is also illustrated in heating with a hot-air furnace. Air comes in contact with the heating dome of the furnace, where it takes on heat. It then rises through a pipe to a cold room, bringing its heat with it into the room.

The third process of heat transfer is a peculiar one, for here the heat travels, not on matter, but on the *ether*, which is supposed to pervade all space, and is believed to be a carrier of waves of heat and of light. The process is called *radiation*. Perhaps this will help you to understand why the word *radiator* is appropriate to some pieces of heating apparatus.

A. If you put your hand on a warm iron, by what process does the hand gain heat?

B. If you stand in sunshine, by what process does your body get warm?

C. If you sit in a warm draft of air, by what process is the heat brought to your body?

3. Automatic regulation of body temperature. The blood is the great carrier of heat over the body, getting its heat, as was said before, from the active muscles and glands. When the temperature of the surrounding air is more than 70° F., the greater part of your blood is near the surface of the body. When this temperature is between 68° F. and 70° F., the blood is about evenly distributed near the surface and deeper in. When this temperature is below 68° F. the blood tends to leave the surface and goes deeper in. The blood is withdrawn from the surface as the temperature is reduced in order to keep from giving off so much heat directly to the air around. The skin then gets colder, and the muscles go to work of their own accord so as to produce additional heat. But they sometimes contract irregularly, and that is why one shivers.

A. Why is a surrounding temperature of 68° to 70° best for one who is not vigorously working?

B. Why does the skin get so pale when it is very cold?

C. Why are the veins of the skin so full on hot days?

D. Why does your face get red when you are standing near a hot stove?

4. Water evaporation in moving air. Because the human body perspires only to get rid of heat, it becomes important to get at some of the facts about evaporation. Put two or three drops of water in each of two saucers, keep them in a moderately warm room, fan one of them so as to keep the air in motion over it, and note the time it takes the water in each to evaporate.

A. Why do fanned drops of water dry up more quickly than drops not fanned?

B. What was the difference in the time required for the two quantities of water to evaporate?

5. Effect of evaporation on surrounding temperatures. To study an important effect of evaporation, take an ordinary dairy thermometer, insert its mercury bulb in a small bottle of ether or gasoline, and let stand for a few moments. Now take the thermometer out, read it quickly, and then watch what the mercury column does while the ether is evaporating from the bulb.

A. What was the reading of your thermometer at the moment it was taken from the ether?

B. Through how many degrees did the mercury change?

C. Why did the mercury column then go back to where it stood at first?

6. Sensory verification. Pour a few drops of ether or gasoline on your hand.

A. How does your hand feel when ether or gasoline is poured on it?

B. What is the effect on temperature when a liquid is evaporating?

C. What purpose seems, therefore, to be served by your perspiring?

Exercise II. Some Studies of Ventilation

1. Two primary reasons for ventilation. Provide a cabinet such as is shown in Figure 69 or in Figure 70. After airing it out well, and after noting the temperature of the room, enter the cabinet. Unless there is an electric fan in the cabinet, take along a palm-leaf fan. Close the door. For the purpose of this study, the cabinet may be called a *ventilation cabinet*. Remain in the cabinet until the temperature within is about 80° F., or preferably higher, certainly until you are uncomfortably warm and sweaty, and have a feeling of closeness in the air. At this

Fig. 69. An ordinary schoolroom closet converted into a ventilation cabinet. Note the electric fan and the way in which the pupil's head fills the opening. She gets outside air for breathing, yet no air from the outside can get mixed with the air inside the closet.

time take the temperature of the air in the cabinet by means of a dairy thermometer hung down through a small hole in the top of the cabinet or perhaps through a hole in the side. Now stir up the air vigorously with the fan for a minute or less, in order to break up the vapor jacket of air next your skin, meanwhile pulling the

clothing away from your body as much as possible. Again take the temperature inside the cabinet, and record any change in temperature the thermometer may show.

A. What temperature change did you experience in your ventilation cabinet experiment when the air inside was stirred?

B. Why did the change seem to you much greater than the thermometer showed it to be?

C. Why did the breaking up of the jacket of moist air next the skin serve to cool you?

D. What is an important reason why the air of a living room needs to be kept stirring?

E. From what you noticed about the air in the cabinet, as you came out, give another reason why the air of a living room needs to be changed and why one should bathe.

F. What do you think is the chief source of bad air in a crowded room, as you judge from your experience on the way out of the cabinet?

G. Judging by the effect of the fanning, what is the most important reason why a living room needs to be ventilated?

H. What is a second important reason why a room needs to be ventilated?

2. A third reason for ventilation. Turn back to the end of Study Four and find how many cubic inches of air you breathe in an hour. Since one twentieth of each breath corresponds to the amount of oxygen you use up every time you breathe, find this amount in cubic inches, and multiply it by the number of breaths you take in an hour.

A. How many cubic inches of oxygen do you need in an hour?

B. How big a square of cardboard would make one side of a cubic box that would contain a supply of oxygen for you for an hour?

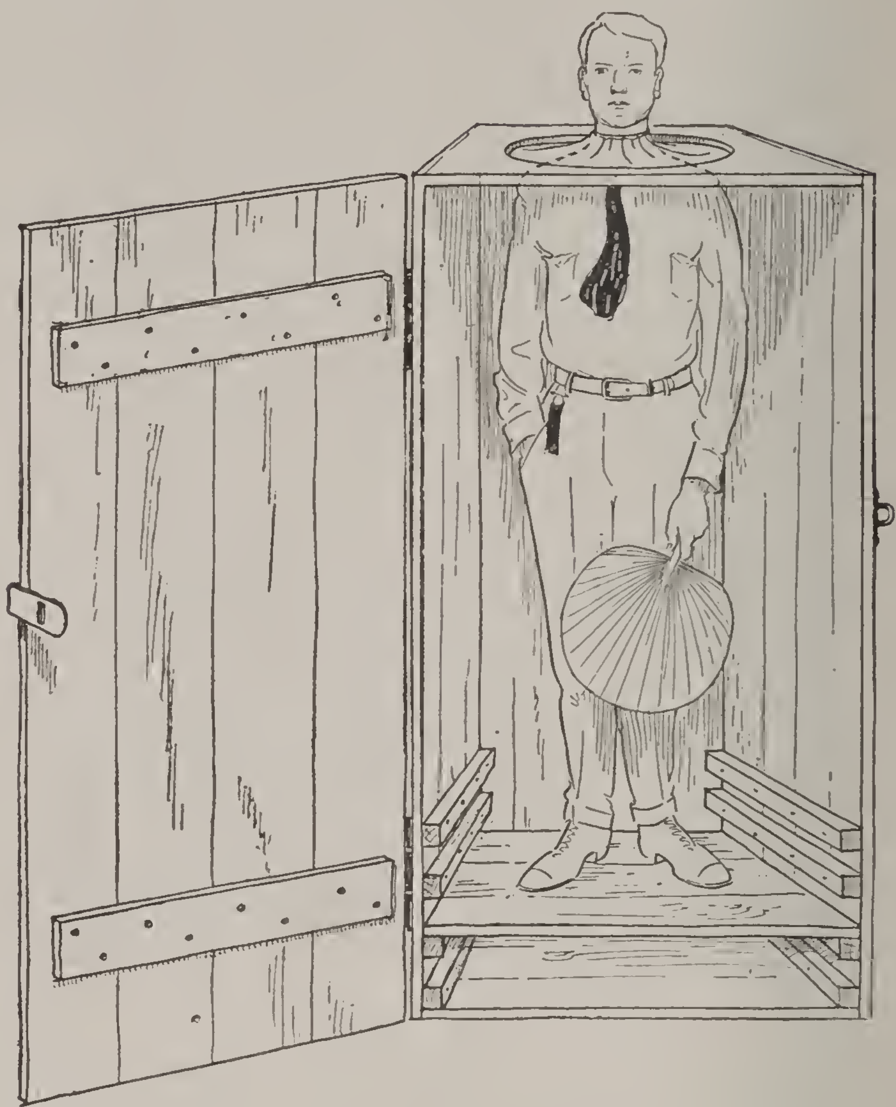

FIG. 70. A cabinet built especially for the ventilation experiment. The floor is adjustable so that people of different heights may stand in the cabinet.

3. The oxygen supply in a bedroom. If you were shut up in an air-tight bedroom measuring 10 x 10 x 8 feet, how long would it be until you had used up all the oxygen available? You remember that you found close to one fifth of ordinary air to be made up of oxygen.

Your closed bedroom would thus contain about 160 cubic feet of oxygen. Still, you are so constructed that you can never take up more than about two fifths of the oxygen found in ordinary air. In your small bedroom, therefore, only about 64 cubic feet, or 110,592 cubic inches of oxygen would be available. Dividing this by the number of cubic inches of oxygen you found that you need in an hour, how many hours do you find that you could stay in a bedroom measuring 10 x 10 x 8 feet, before you would need more oxygen?

4. A fourth reason for ventilation. But there is a condition that would make it necessary for you to leave the room long before you used up the available oxygen, and that is the accumulation of carbon dioxid. At the time you are using up the oxygen from the inhaled air you are adding nine tenths as much carbon dioxid to take its place in the exhaled air. How much carbon dioxid do you give off in an hour?

5. That bedroom again. Careful experimentation by physiologists has shown that one can stay in a room until the quantity of carbon dioxid in it is raised to 3 per cent. of all the air in the room. In the case of the bedroom we have been considering, this will be 24 cubic feet or 42,417 cubic inches. Dividing this by the number of cubic inches of carbon dioxid you give off in an hour, find the number of hours you could stay in the bedroom before too much carbon dioxid accumulated.

A. How many hours is this?

B. Which condition, an excess of carbon dioxid or a shortage of oxygen, would the sooner make you call for fresh air?

6. Carbon dioxid in your schoolroom. Calculate how much carbon dioxid could be endured by one person in

your schoolroom, figuring this at 3 per cent. of the total cubic inches of space. Divide your result by the sum of the cubic inches of carbon dioxid given off in an hour by all the pupils together. How long could all of you stay in your schoolroom before you would have to have air from the outside?

7. **The four reasons for the ventilation of a living room.** Recalling your conclusions from the ventilation-cabinet experiment, you know you need to have a room ventilated long before there is too little oxygen or too much carbon dioxid. Set down in your notebook, in the order of their importance, the four distinct reasons why a living room must be ventilated.

8. **Securing ventilation.** You should now find out the fundamental principle for any system of ventilating a room. Bore two holes in the lid of an empty cigar box. Let them be about 2 inches apart, and an inch in diameter. Place a short lighted candle under one of the holes, close the lid tightly, and then set a lamp chimney over each of the holes. A pasteboard tube an inch or so in diameter and 6 inches long may be substituted for the lamp chimneys. By means of smoke from an extinguished match, discover which way the air is moving at the top of each chimney. If the weather is cool outside, open the window sash about two inches at the bottom and as much at the top. Try placing smoke or chalk dust at each of the window openings, to see which way the air currents run.

A. Which is heavier, cold air or warm air?

B. How is air made to circulate in a room?

Exercise III. Questions for Investigation

1. How do the sweat glands help to regulate the body temperature?

2. In what two ways do the small blood vessels of the skin help to regulate the temperature of the body?

3. What is the danger in chilling the body very much?

4. Why should one be careful not to overheat the body?

5. How does alcohol affect the body temperature?

6. What is the exact percentage of oxygen in ordinary air?

7. What fraction of the oxygen in air does the blood in the lungs take up at a breath?

8. How low a percentage of oxygen may there be in air that will still permit you to live, provided there is not too much carbon dioxid in it?

9. Why is it more important that you should concern yourself about the quantity of carbon dioxid in breathed air than about the quantity of oxygen?

10. What is a poison?

11. Some books say that carbon dioxid is poisonous; but is this really so?

12. Why is very dry air injurious to the lungs?

13. What is the best temperature for a living room?

14. Why does the air in a living room need to be kept in motion?

15. How can you ventilate a room and still avoid a strong draft?

16. What is the chief cause of disagreeable odors in crowded rooms?

17. What is an open-air school?

18. What is the advantage of outdoor sleeping?

19. What are some important habits to form with respect to body heat and ventilation?

STUDY FORTY-TWO

SOURCES, FORMS, AND EXITS OF BODY WASTE

CAN you ever completely destroy anything? The answer to this question will depend on what you understand the word "destroy" to mean. You have found in your studies of respiration that when a candle burns, the candle slowly disappears *as a candle.* But you also found that something else was being made as the candle burned: namely, carbon dioxid.

No doubt you have seen moisture gather on a lamp chimney when the cool chimney was first put on after the wick was lit. The moisture was made by the flame, and it showed on the chimney as long as the chimney remained cool enough to condense it. Now, both tallow and kerosene are made from carbon, hydrogen, and oxygen. Carbon dioxid is made from atoms of carbon and oxygen; and water is made from atoms of oxygen and hydrogen. The atoms out of which tallow and kerosene are made are not themselves destroyed in the burning process; but the original substances disappear in the process of the production of new substances.

Similarly, the food that you eat undergoes chemical changes within your body, and it will be interesting to find out what these changes are.

EXERCISE I. THE SOURCES OF FOODS

1. The difference between an atom and a molecule. For your first study you need a number of grains each of three kinds of seeds — as wheat, popcorn, and rice. Assume that each grain of rice represents a particle, or *atom*, of oxygen; that each wheat grain represents an atom of carbon; and that each popcorn grain represents

an atom of hydrogen. Paste together one wheat grain and two rice grains. This combination, or *compound*, will represent a particle, or *molecule*, of carbon dioxid. Make twelve such representations of molecules of carbon dioxid.

In similar fashion make an illustrative molecule of water out of a grain of rice (representing an atom of oxygen) and two grains of corn (representing two atoms of hydrogen). You will need ten such "molecules" representing water. In your work with these "molecules" the paste or glue represents the energy, or power, with which the atoms of molecules are held together. What is the difference between an atom and a molecule?

2. **Storing energy in complex molecules.** On the left side of a piece of paper lay down together 6 of your "molecules" representing carbon dioxid, make a plus mark at the right of this pile, and to the right of the plus mark lay down 5 "molecules" representing water. Now make the sign of equality to the right of the "water." Take the 6 remaining "molecules" representing carbon dioxid and the 5 representing water, and, by the use of more "energy" (paste), make of these 11 simple "molecules" a single complex "molecule."

Pick out from the mass of this single complex molecule, 12 of its "atoms" of "oxygen." What you have left is a single "molecule" of "starch." Lay the "starch molecule" to the right of your equality sign, make another plus mark, and then lay to the right again the twelve "oxygen atoms" in six pairs. The whole of this now represents what is called a *chemical equation*. If $6\ CO_2 + 5\ H_2O$ represents the first half of the equation, how will you write out the whole equation?

3. **Where starch gets its energy.** To make your chemical equation entirely true to all the facts, you would

have to write it 6 CO_2 + 5 H_2O + energy = (what you wrote before to finish the equation). The significant point about this is that when a large or complex molecule is made from a few simple ones, it takes *additional energy* (represented by your paste) to do it.

Study Figure 71 and note especially the leaf labeled

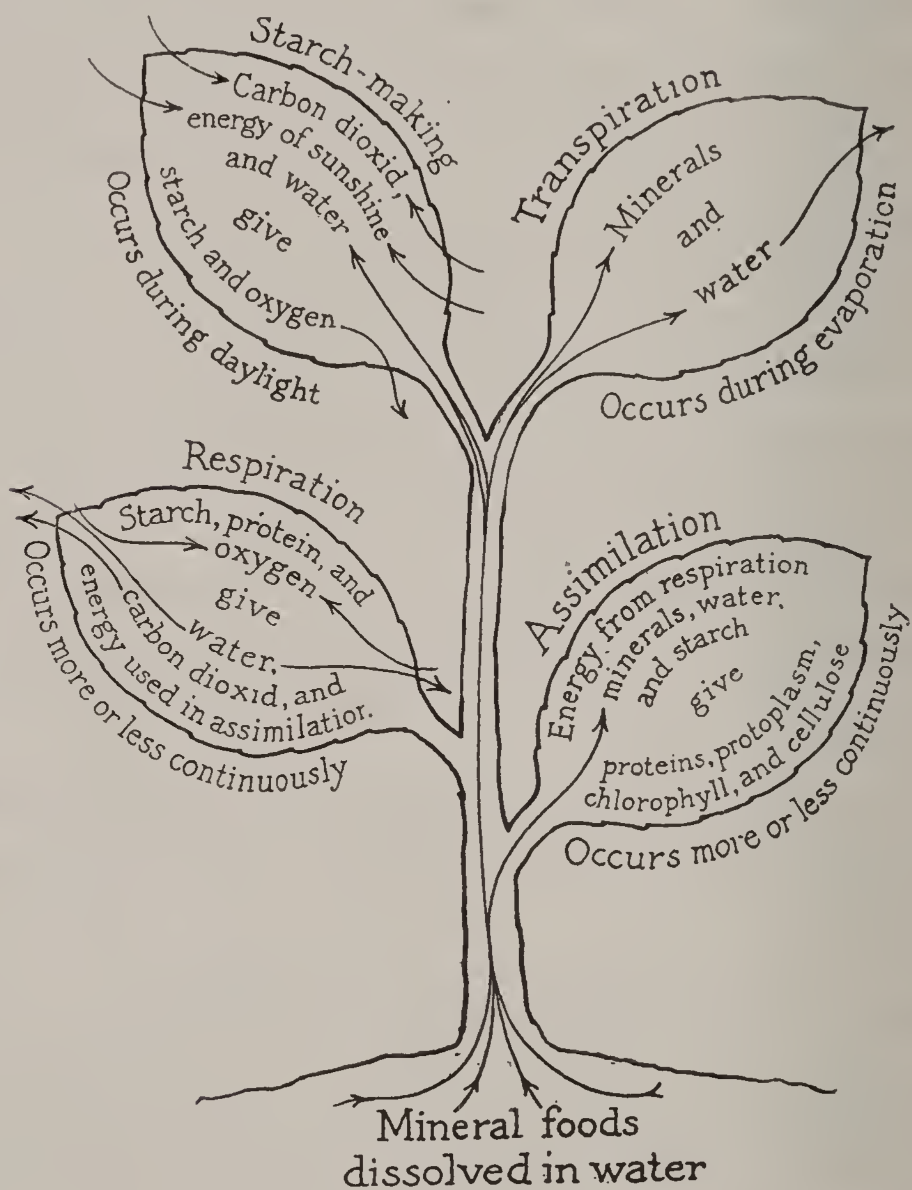

FIG. 71. The life functions of a plant. A plant supplies its needs largely from the air. The leaves serve as lungs, and also as a place for the manufacture of food.

starch-making, and from it find answers to the following questions:

A. What is the complete equation for the making of starch?

B. What is the source of the energy for the making of starch in nature?

C. What is the source of the carbon dioxid used by a leaf?

D. What is the source of the water used by a leaf?

4. **Proof that sunshine is necessary in starch making.** Take a potted plant with thin leaves, such as a nasturtium, and in the center of one leaf pin together the parts of a divided cork as shown in Figure 72. The cork is to keep the sun from shining on the part of the leaf it covers. Make the mounting at the beginning of a day of sunshine, and in the evening remove the cork and the leaf. Put the leaf at once into a cup of denatured alcohol and let stand for half an hour, until the green substance in the leaf is dissolved out. The leaf can then be kept until you are ready to apply the starch test to it, the next step in this experiment. When ready, dip the leaf in some tincture of iodin and note the distribution of starch in the leaf.

A. What did your starch test show as to the distribution of starch in the leaf experimented with?

B. Why was the starch missing *at the one spot?*

C. What three things are necessary in the making of starch? (See Figure 71.)

D. Why do not the grains on growing corn ears fill very well with starch in seasons when it is cloudy or rainy in late August and early September?

5. **How energy is got from starch.** You have now learned that it takes energy to make starch. Indeed, starch is not unlike a wound-up watch spring, for it con-

FIG. 72. A nasturtium plant with one leaf in preparation for the starch test. A bit of shingle furnishes the support for leaf and cork.

tains stored-up energy. You eat starch to get its energy or power. This energy you use in producing muscular contraction to effect various movements. Of course, the starch is changed to grape sugar (see Study Thirty-two) so it can be carried around by the blood to the muscles, where it is again made into a kind of animal starch, called *glycogen*, and stored for use. The energy you get from it, when finally it is used, was originally sunshine, as you saw from the fourth experiment in this study.

To get this energy turned loose in your muscles you must have some oxygen to take hold of the stored starch grain and break it up into carbon dioxid and water, thus

releasing the energy. The chemical equation that would show this is the same one you had for the answer to *A* under the third experiment, only the part at the left of the equality sign must change places with the one at the right of it.

A. What is the chemical equation for the breaking up of starch in the human body?

B. Why is air as important for you as food?

C. What are the two distinct reasons why you breathe?

6. The composition of a molecule of fat. In somewhat similar fashion you can make a study of fat. Consider a common kind of fat, such as the one that gives the peculiar flavor to butter. This fat is called *butyrin*, and it is made up of 15 carbon atoms, 26 hydrogen atoms, and 6 oxygen atoms $(C_{15}H_{26}O)_6$. If you recall your work with the cereal grains to represent the atoms of a grain of starch, you will see that more extra energy, represented by paste, would be necessary if you were to try to follow the same procedure in representing a molecule of fat.

A. Turning to the second exercise in Study Thirty-three, what do you find to be the heating power of an ounce of butter as compared with that of an ounce of starch?

B. Why should fat yield so much more energy when burned than starch does?

7. Composition of a molecule of protein. Protein molecules are still more complex than either carbohydrates or fats, mainly because they are made of more kinds of atoms or elements. In addition to carbon, hydrogen, and oxygen, a protein molecule always contains nitrogen, and then various other atoms, such as phosphorus, sulfur, and iron. Thus, you can see that when a protein molecule goes to pieces in the human body, it gives up

substances besides simply carbon dioxid and water. One of these substances is *hydrogen sulfid*, the gas that makes rotten eggs smell so bad. There are a number of other forms of waste from proteins, but they are too complex and varied for you to consider here. Why do decaying proteins smell so much worse than decaying carbohydrates or fats?

Exercise II. The Forms of Body Waste

1. **Carbon dioxid as a form of waste.** There are only three major forms of body waste; but there are many minor forms. Carbon dioxid is one of the three major forms, and it comes from each of the three principal kinds of organic foods you have just been studying. In answering the following questions, keep in mind what you have just learned; and recall your studies of respiration in Study Thirty-six.

A. What are the three kinds of primary foodstuffs, each of which yields carbon dioxid when broken up in the body?

B. What is the appearance of carbon dioxid?

C. What organs remove excess carbon dioxid from the body?

D. Why would you die if you were to get into a room, or a well, or a vat, where the air contained a large proportion of carbon dioxid?

E. How does the carbon dioxid get around to the lungs from the muscles and glands and other tissues, where it is originally made.

2. **Water as a form of waste.** Water is the second of the three major forms of body waste. You wonder, perhaps, why water should be a form of waste, since you know that it is one of the substances the body most

needs. It is true that water is taken into the body in considerable quantities, but its main purpose is to act as a carrier for other substances. It forms nine tenths of the liquid part of the blood, and an equal proportion of the lymph among the cells. It is present also in the protoplasm of which the cells of the body are made. Indeed, the body as a whole is nearly seven tenths water.

In the course of a day, about a pint of water is made in the body when foods break up in the tissues; but this is not enough to do the carrying of dissolved food and waste, and more water has to be supplied.

Water is a waste material only when it is needed to carry off waste, or when it is given off by the body for other purposes, as to moisten the air one breathes or to reduce the body temperature through perspiration.

A. What are the three primary foodstuffs that yield water as they break up in the body?

B. How much water should you drink on a moderately warm day?

C. When should most of the water be drunk, at meal times, or between meals?

D. What two organs, besides the kidneys, take water out of the blood and eliminate it from the body?

3. **Urea as a form of waste.** The third major form of body waste is a substance that has not been spoken of before. It is made from broken-down proteins. A molecule of it is composed of 1 carbon atom, 1 oxygen atom, 2 nitrogen atoms, and 4 hydrogen atoms (CON_2H_4) and is called *urea*. The liver is the organ that makes this urea. The liver throws the urea into the general blood stream, and thus the urea goes all over the body, to be finally sorted out from the blood by the kidneys. A sample of urea can be purchased at any well-stocked drug store.

A. What is the appearance of urea crystals?

B. Under what conditions would there be likely to be a large amount of urea in the urine?

4. **Some minor forms of waste.** There are various minor forms of waste coming from the body, only two of which you will have a chance to consider here.

A. Examine a specimen of bile, as from a chicken's liver, for bile is partly a form of waste. Where is bile stored, and what is its appearance?

B. The indigestible parts of all foods pass along the food canal and collect in the terminal part of it, where the waste then takes the name *feces*. Why are the feces of vegetable-eating (*herbivorous*) animals less offensive in smell than those of meat-eating (*carnivorous*) animals?

Exercise III. Exits of Body Waste

1. **Examining a kidney.** Secure a specimen of a hog's kidney and cut it in halves the flat way. Notice the central chamber of the kidney where the urine first collects. Notice also several little pyramid-shaped, lighter-colored bodies that point toward the central chamber from the outer part of the kidney. These are made up of numerous fine tubules that collect the urine from the blood. The central chamber of the kidney is drained off at one side by a tube leading to the bladder, where the larger mass of urine is collected.

From previous study you know that urine is made up of water and urea. It also contains some other wastes, such as uric acid and various salts.

A. In your notebook make a sketch or drawing of the inside of a kidney.

B. What are at least four of the forms of waste that the kidneys throw off?

C. The blood comes to the kidneys almost directly from the lungs, where it has lost its excess of carbon dioxid, and the kidneys take out the two remaining major forms of body waste; namely, water and urea. In what veins, then, would you expect to find the most nearly pure blood?

D. Why is it so exceedingly important to keep the kidneys in healthy condition?

E. What is Bright's disease?

2. **The lungs as organs of elimination.** See Studies Thirty-six and Forty-one.

A. What forms of body waste are thrown off by the lungs?

B. What proportion of its load of carbon dioxid does the blood give up as it passes through the lungs?

C. Of the air you exhale, what proportion is carbon dioxid?

D. What is the highest percentage of carbon dioxid that there may be in the air, leaving it fit for breathing?

3. **The skin as an organ of elimination.** See Studies Forty and Forty-one.

A. In the incidental work of the skin, what three forms of waste matter are thrown off? Name them in order of their importance.

B. Why do the kidneys have to discharge less water on warm days than on cold days?

4. **The terminal part of the food canal.**

A. How frequently should you discharge the feces?

B. Why is constipation so undesirable a condition?

C. Why is eating an excess of protein undesirable?

D. What is an important reason why you should drink plenty of water?

5. **The liver as an eliminative organ.**

A. What form of waste is manufactured and thrown off by the liver?

B. Where is the waste stored before it is thrown off?

C. Where does this storage organ empty its waste?

Exercise IV. Questions for Investigation

1. What is meant by the expression "food is oxidized in the body"?
2. What is the principal use of protein in the body?
3. What are the three principal forms of waste products from the body?
4. Where are the kidneys located?
5. What are the principal functions of the kidneys?
6. When more carbohydrates or fats are eaten than are needed by the body, what becomes of the excess?
7. Where is the protein food mainly stored in the body?
8. Why do famine sufferers become so emaciated?
9. If more protein is eaten than the body needs, what becomes of it?
10. How do proteins from meats compare with those from vegetables in nourishing power?
11. What is gelatin, and what is its food value?
12. What are four reasons why you should not eat much meat?
13. Why does a boy or girl require as much food as an adult?
14. Do most boys and girls eat too much food, or not enough?
15. What are the foods upon which you can mainly depend for your supply of energy?
16. What should be the difference between a winter and a summer diet?

17. What is the chief source of supply for the body's need of minerals?

18. What are vitamins, and what foods yield them?

19. Why is milk so important a part of a healthful diet?

20. Why should you not eat a large amount of sugar or sweets?

21. How much fat should be included in the daily ration?

22. Why should you eat plenty of coarse vegetables?

23. What are three good rules for a proper diet?

24. Why is constipation a serious enemy of mankind?

25. What are some foods that will help to relieve constipation?

26. How will a knowledge of foods help one to gain health and to save money at the same time?

27. What are some good habits to form with respect to getting rid of your body wastes?

STUDY FORTY-THREE

BONES AND JOINTS

When your fathers and mothers went to school and studied physiology, the schools paid a good deal of attention to teaching the names of the bones of the body. Because learning a list of bones was found to be pretty uninteresting work, some people have taken the extreme view that the bones should be studied scarcely at all. However, a study of the human body without attention to the skeleton would be as absurd as the study of an automobile without regard to the chassis.

Exercise I. Studies of Bones

1. **The bones of your skeleton.** By feeling the bony parts of your body, or by studying a mounted human skeleton, find out, as nearly as you can, how many different bones there are in each of the following organs: the fingers and free part of the thumb; the palm of the hand; the wrist; the forearm; the shoulder; the head; the face; the chest; the backbone; the hips; the thigh; the leg; the arch of the foot; the toes of one foot.

2. **The structure of a bone.** Obtain a fresh bone that is several times longer than wide, and saw it in two lengthwise, using a butcher's saw or an ordinary hack saw. Obtain a similar dry bone and saw it in two likewise. Chicken bones will do, but larger bones will be better. Examine your specimen and then describe the following parts: The membranous covering, known as the *periosteum;* the shell of very hard bone on the outside, the *compact bone;* the porous bone appearing in the ends of a dry bone, the *spongy bone;* the red mass within the spongy bone, the *red marrow;* the yellowish, soft matter in the

FIG. 73. These boys cleaned and mounted this skeleton of a dog. The job was tedious, but interesting; and the boys learned a lot about bones while they were at it.

center of the bone shaft; the *fatty marrow;* and finally the space occupied by the fatty marrow, called the *medullary cavity*.

3. **Shapes of bones.** In general, bones are classified into four different groups as to the shape — the *long*, the *short*, the *flat* and the *irregular*.

A. A long bone is one that is more than twice as long as it is wide or thick. There are at least 60 such bones in your body. Where are they?

B. A short bone is one that is less than twice as long as it is wide. What are the locations of some short bones?

C. A flat bone is one that is much longer and wider than it is thick. Where can you find examples of such bones?

D. An irregular bone is one that has dimensions that are not regular. A good example is a *vertebra*, one of the bones that make up the backbone or *spinal column*.

Secure a dry vertebra of some animal and examine its biggest part, the *body*, and the pointed parts, the *processes*. What are the uses of the following: the body, the processes, and the hole through the middle?

4. **The composition of bones.** Into a wide-mouthed bottle put a small piece of limestone or marble and pour over it a 20 per cent. solution of dilute hydrochloric acid. Into another bottle put a reasonably fresh drumstick of a chicken, and cover it also with a 20 per cent. solution of hydrochloric (muriatic) acid. Let both stand for a day.

A. What happened to the limestone kept in the acid?

B. What happened to the chicken bone kept in the acid?

C. How can you now tie a knot in the chicken bone?

D. What was taken out of the bone was called *mineral* matter and what remained is *animal* matter. What does the mineral matter seem to do for a bone, and what does the animal matter seem to do?

Exercise II. Studies of Joints

1. **Examining a joint.** Obtain a fresh hip joint of a pig or other animal. If the outer sheathlike covering is still on, examine it to see how the joint is protected. Now remove this sheath by suitable cutting, and note the smooth coverings of the bone ends. The material that covers the bone ends is called *cartilage*.

A. How does cartilage differ in at least three ways from compact bone?

B. Where in the human body can you locate specimens of cartilage?

C. Why does a joint work so easily?

2. **Nature and use of ligaments.** Find in your specimen of a joint the white cords, called *ligaments*, that help

to tie the bones together. Separate one of these out and see how a ligament differs from cartilage and from bone. Also find any similar white cords, known as *tendons*, that were fastened at one end to the bone and at the other end to a muscle. You can feel such cords at the back of your own knee.

A. A ligament and a tendon differ from bone in what ways?

B. A ligament and a tendon differ from cartilage in what ways?

C. A ligament differs from a tendon in what way?

3. **Kinds of joints.** We are accustomed to describe different kinds of joints by the motions they permit. If the motion is like that of a hinge, as in the knee, it is called a *hinge joint*. If two nearly flat surfaces pivot, as in the neck, the joint is called a *pivot joint*. If a joint permits a conelike motion and also lets one bone rotate or twist on the other, as in the shoulder joint, it is called a *true ball-and-socket joint*. If it permits a conelike motion but does not let one bone turn or twist on another, as in the wrist joint, it is called a *false ball-and-socket joint*. Now proceed over the body to find all the examples of these joints you can. How many of each can you locate? Keep in mind that there is a joint *between* the wrist ends of the forearm bones, and that there are two distinct kinds of joints at the elbow — one for each of the forearm bones.

4. **Obtaining a skeleton.** It is possible to illustrate many important facts about the framework of an animal by using the skeleton of a dog or other small animal, such as you yourself can mount. It will take some chemicals and a little work to prepare such a skeleton, but you will be proud of the result. Your mounted specimen should

be properly labeled and left in your school museum. See Figure 73. By turning to page 23 of Hartman's *Laboratory Manual of Human Physiology*, you will find complete directions for freeing a skeleton of its flesh, and for mounting the bones.

What success have you had in mounting the skeleton of an animal?

Exercise III. Questions for Investigation

1. What is a skeleton, and what is the origin of the word "skeleton"? See the big dictionary.
2. What bones make up the spinal column?
3. Why would it be particularly dangerous to a baby if any weight were to fall on top of its head?
4. How many pairs of ribs have you?
5. What is the scientific name for the breastbone?
6. What two bones make up the shoulder bones?
7. What are the pelvic bones?
8. What are the bones in your arms?
9. What are the bones in your thighs and legs?
10. What two kinds of matter make up bony tissue, and how do they differ from each other?
11. What is a true joint?
12. What is cartilage?
13. What is a ligament and what is a tendon?
14. Why is it important to take good care of a sprain?
15. What is a dislocation?
16. What should one do in case of a broken bone?
17. Why do the bones of children need special care?
18. Why do the bones of old people need special care?
19. What are some good habits to have in order to keep bones and joints in good condition?
20. What are some practices to avoid, if a good body framework is to be preserved?

STUDY FORTY-FOUR

MUSCLES: POSTURE, EXERCISE, AND FATIGUE

THERE is a saying that "a noble soul dwells in a strong body." It is true, of course, that many a noble soul has dwelt in a weak body, and that many a mean spirit has dwelt in a strong body. But most of those who have made the world a little better than they found it, have been men and women of sound physique. Think of the names of a dozen famous men, about whose lives you have read. Most of them, like George Washington, had more than ordinary physical vigor. It is clear that if you are to do your best, you must have health and strength. How are you to attain these, and how are you to retain them? To begin with, a knowledge of the facts about the workings of the muscular system is highly important.

EXERCISE I. STUDIES OF MUSCLES

1. **Examining a muscle.** From a chicken or other small animal take a whole muscle with its tendons, and note the difference between the body of the muscle and its tendons. Also note how the tendons connect with both the muscle body and the bone.

A. The body of a muscle differs in what ways from its tendons?

B. To what does a tendon usually tie a muscle?

2. **Studying muscle tissue.** Take a specimen of boiled beef and examine its structure. You will readily see that it is made up of little bundles of muscle tissue each about as big across as a match stem. Now take one of these bundles and pick from it the tiniest possible thread, as small at least as a fiber of cotton or of silk. Such a thread, if examined under a microscope, will be found to

FIG. 74. The ergograph. This is the fatigue-testing machine that can be made. The metronome should be set to tick sixty times a minute.

consist of several still finer threads, called *muscle fibers*. If possible, mount one of these fibers under a compound microscope. What is the appearance of a boiled muscle fiber when seen under a microscope that magnifies 100 to 500 times? (See Figure 38.)

EXERCISE II. STUDIES OF POSTURE

1. **Review.** Recall or reproduce the studies of posture in Study Two. What do you learn from your review of that Study?

2. **Your posture diagram.** Send to the American Posture League, 1 Madison Avenue, New York City, for a chart of posture. Make a diagram representing your own posture. (See Figures 3, 4, and 5.) What can you do to correct the imperfections of carriage you may have, if any?

3. **Studying your footprint.** If you have not already done so, take a footprint as directed in Study Two. Paste your footprint impressions in your notebook and consider how you can improve your feet, if they are not as they should be.

EXERCISE III. STUDIES OF EXERCISE AND ITS EFFECT

1. **Reporting your condition.** After you have been comparatively quiet for a time, count your pulse and breathing-frequency for a minute, and take note of your temperature, blood distribution, perspiration, relative quantity of air you naturally breathe at a breath, and how you feel. Now run for a tenth to a fifth of a mile, or around a city block, and at once reëxamine yourself on all points listed above. Fill out the table below.

RECORD OF	FIRST MEASUREMENT	SECOND MEASUREMENT
Pulse	....	....
Breathing rate	....	....
Seeming temperature	....	....
Blood distribution	....	....
Air breathed at a breath	....	....
Feeling of well-being	....	....

2. **Use of valves in veins.** Recall or repeat the seventh experiment under Exercise I of Study Thirty-eight.

A. What happens to the blood in a vein when pressure is applied at a point on the vein?

B. How does exercise serve to pump blood along in the veins that are in muscles?

3. **The value of exercise.** Place in a wash basin full of clean water, sponges that have just been soaked with dirty water. Squeeze one of these sponges repeatedly while it is under the water in the pan, and then remove both sponges. Compare the cleanliness of the two sponges, by observing the condition of the water you can now squeeze from each.

We shall presently find that muscles accumulate waste matter when they are made to work vigorously. If a muscle has fatigue waste in it, vigorous rubbing and squeezing of the muscle will help to clear it of its waste. This rubbing and squeezing process is called *massage*.

A. How does exercise serve to clear the muscles of waste material?

B. Why cannot medicine ever take the place of exercise?

C. Can automobile riding take the place of vigorous exercise for maintaining high vitality?

D. Why is massage helpful in reducing stiffness, after vigorous exercise?

Exercise IV. Fatigue Experiments

1. **Taking a fatigue record.** For taking a fatigue record there will be needed a fatigue machine such as is shown photographically in Figure 74 and diagrammatically in Figure 75. A more nearly perfect machine is one known as Gregg's *Ergograph*, to be had from the C. H. Stoelting Co., Chicago, Illinois. In the experiment itself, the one whose record is to be taken sits by the apparatus, his right hand and elbow resting as shown in Figure 75. The middle finger is trust through the leather or cloth loop, which

in turn is tacked to the left-hand end of the weight carrier. Tie the index finger firmly in place. Now put two pounds

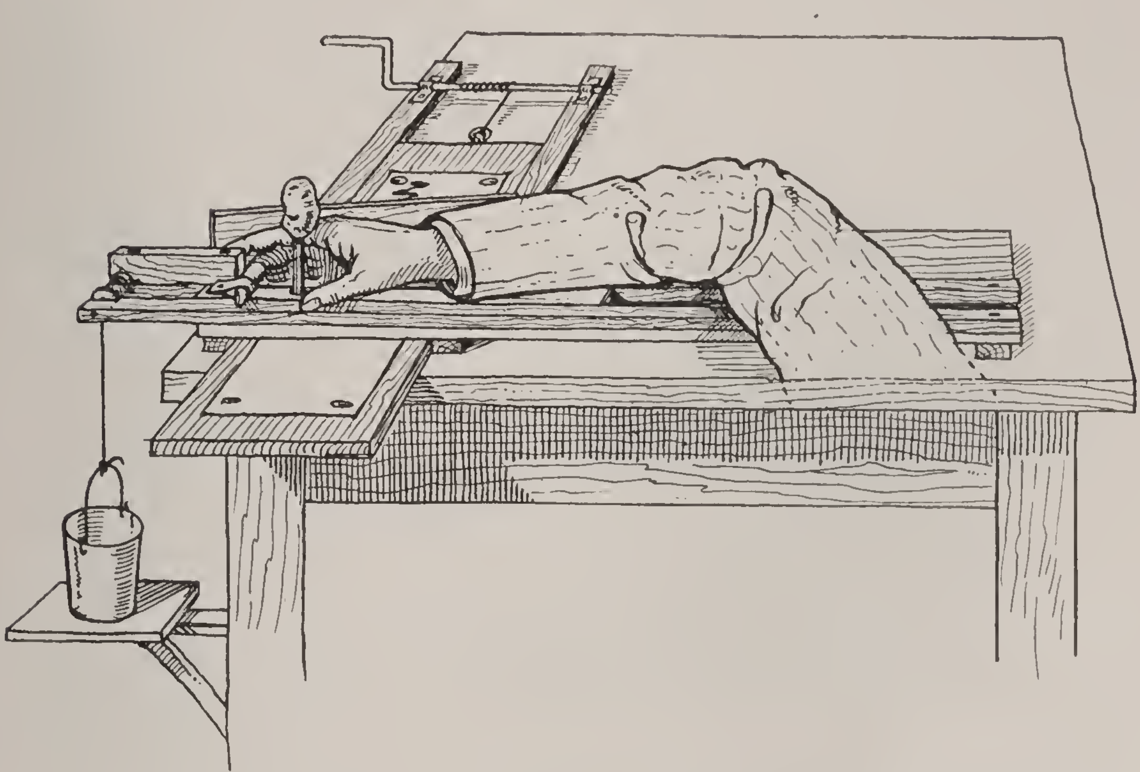

FIG. 75. An ergograph or fatigue apparatus as it may be constructed by members of the class.

of weight into the bucket and let the experimenter lift the weight with his middle finger only, as far as he can, once every second. Meantime, the operator will have to turn the windlass slightly each instant the finger of the experimenter lets the load drop back. This is to cause the record board to pass under the pencil point. The record that is made in a minute to 60 strokes of the metronome should taper from broad strokes—almost across the sheet at first—to a thin point which indicates arrival at fatigue. If the record is not like this, increase or lessen the weight in the bucket and try till such a record results. The idea is to see what is the heaviest weight you can

carry and reach the state of fatigue in about a minute. Paste your fatigue record in your notebook.

2. **The effect of rest periods.** After several hours' rest, repeat the fatigue experiment, but this time lift the former load once in two seconds instead of every second, and continue for two minutes.

A. Paste your record in your notebook.

B. Why did you not reach a state of fatigue this time as you did before?

Exercise V. Questions for Investigation

1. Of what is a muscle composed?
2. How do muscles move the body?
3. What is a tendon?
4. How do you manage to walk?
5. What is the difference between running and walking?
6. How is the trunk held erect?
7. How is the head held erect?
8. How can you stand erect?
9. Give five rules for good posture in standing and walking.
10. What is the vertical-line test for posture?
11. What is flat-footedness?
12. Just where is the difficulty in a case of flat-footedness?
13. How is flat-footedness to be corrected?
14. What should be the position or direction of the foot in standing?
15. What should be the position or direction of the foot in walking?
16. What health habits should you observe in respect to posture, exercise, and fatigue?

STUDY FORTY-FIVE

BEHAVIOR AND THE NERVOUS SYSTEM

Why do people behave as they do? Why do they laugh or cry, get angry or control themselves, flee from danger or else meet it courageously? Why do they do any of their many acts? Such questions have doubtless puzzled you. Whatever the final answers may be, they will have to be sought in a study of the mind and the nervous system. The more you know about the mind and the wonderful nervous system by which your body is controlled, the more you will come to understand your own behavior and that of other people.

Exercise I. Studies of Behavior

1. **Reflex acts.** Recall your behavior on touching something hot.

A. Did you have to think about jerking your hand back?

B. If you tickle a sleeper's toes, will he move before he awakens?

C. What are reflex acts? Give examples.

2. **Instinctive behavior.** Recall your behavior when you suddenly came upon a snake, if you are afraid of snakes.

A. Did you have to know there was something to be afraid of before you ran?

B. Did you have to think at all while you were scared?

C. Was your behavior simple, or were there a lot of acts going on at the same time?

D. Fighting, crying, being curious, and "showing off" are instinctive acts. In the light of the answers to Ques-

Fig. 76. An immigrant woman and her two sons. The man at the left has been in the United States for a number of years, while the one at the right has just landed with his mother. These men, of the same heredity, have had very different concerns in life—their behaviors have been different—and the story of each of them is rather plainly written on his face.

tions *A*, *B*, and *C*, what definition can you give for the term "instinct"?

E. How does instinctive behavior differ from reflex action?

3. **Voluntary behavior.** Play a game of "Simon-says-thumbs-up." If you do not know this game, ask some older person how to play it. While playing the game, consider how you get your hands to do just what they ought to do.

A. What is it you have in mind when your hands come up at the time they should stay down, in a game of "Simon-says-thumbs-up"?

B. What is really in your mind when the hands stay down both when they ought to and when they ought not to?

C. What seems to precede every willed act?

D. How does such an act differ from a reflex act?

E. How does such an act differ from an instinctive act?

4. **Habits.** Whistle or sing, and draw a picture at the same time.

A. Which of the two acts do you think about the more and why?

B. What is a habitual act?

C. How does such an act differ from the other three forms of behavior mentioned: namely, reflexes, instincts, and deliberate or idea-controlled acts?

Exercise II. Examining the Brain

1. **The parts of a brain.** Secure as complete a specimen as possible of a sheep's or a hog's brain with as much spinal cord still attached as may be. Any quadruped's brain will serve. Wash the specimen thoroughly after removing the covering membrane, if there is any, and put it to soak for several days in a 10 per cent. solution of formalin. When ready to study it, remove and wash thoroughly in water. Examine the specimen until you become reasonably well acquainted with its more important parts, such as the *cerebrum* or larger portion, with its parts separated by a deep fissure; the *cerebellum* lying just behind and partly under the cerebrum; the *medulla* lying behind and under the cerebellum and connecting directly with the stump of the *spinal cord*, which is the part of the nervous system found in the spinal column. On the underside of the center of the cerebrum find the roots of the *optic nerves;* under the medulla find the roots of several other *nerves.*

In the figures that follow, or on drawings made from them, label the parts of the brain that have been named.

FIGS. 77, 78, AND 79. The brain of a sheep: top, underside, and cross section.

2. **The inside of a brain.** Place the brain so that its forward part will be turned toward you, and its upper side uppermost. You have already found a long fissure separating the two halves of the cerebrum. With a sharp knife, at right angles to the big fissure, cut down through the brain a third of the way to the rear of its forward end. When cut, the surface should look like that in Figure 79. Note the gray surface of the cerebrum, known as the *cortex* or *gray matter*. This gray matter is believed to be the seat of the thinking part of the brain — the place from which voluntary acts are directed.

You should find two circular masses of gray matter near the center of the brain, each called a *thalamus* (plural *thalami*). The thalami are supposed to be the seat of agreeable and disagreeable feelings, and of instinctive actions. The cerebellum, working in connection with the fore brain, has a good deal to do with habits, it is believed. The medulla and the spinal cord take care of reflex acts. The nerves, of course, carry nerve messages.

On a copy of Figure 79 in your notebook, write at one

side the names of the parts of the brain that have been mentioned in the paragraph above, and on the other side write the use of each of the parts.

3. **The development of animal brain.** Study the five types of brain models shown in Figure 26. You will notice that a fish brain has only a very small cerebrum but relatively large parts below the cerebrum. Remembering that the cerebrum is the seat of acts that are learned, and that the parts below are the seat of unlearned forms of behavior, you can now understand why it is difficult to teach a fish anything. Nearly all its acts are the things it simply *has* to do.

Following the series of pictures of brain models along from fish to man, you will note that the cerebrum of each is increasingly large. You will also recall that a frog can learn more than a fish, though not very much more, an alligator more than a frog, a dog much more than an alligator, and a man incomparably more than a dog. Having a large cerebrum enables a creature to perform a great variety of acts and gives it a larger control over its living conditions.

A. What three forms of behavior in general are alike in man and in the lower animals? What form of behavior in man is almost absent among the lower animals?

B. Why is this so, as you judge from the series of brain models shown in Figure 26?

4. **Explaining human behavior.** In order to get a little further into the question as to why people do what they do, you need to examine Figure 80. After studying the diagram carefully, try to answer the questions following it, bearing in mind that the purpose of the cerebrum, or upper part of the human brain, is to control, or hold in check, the thalami and the lower parts of the brain.

A. Why is a very young child's behavior more like that of a lower animal than like that of an adult?

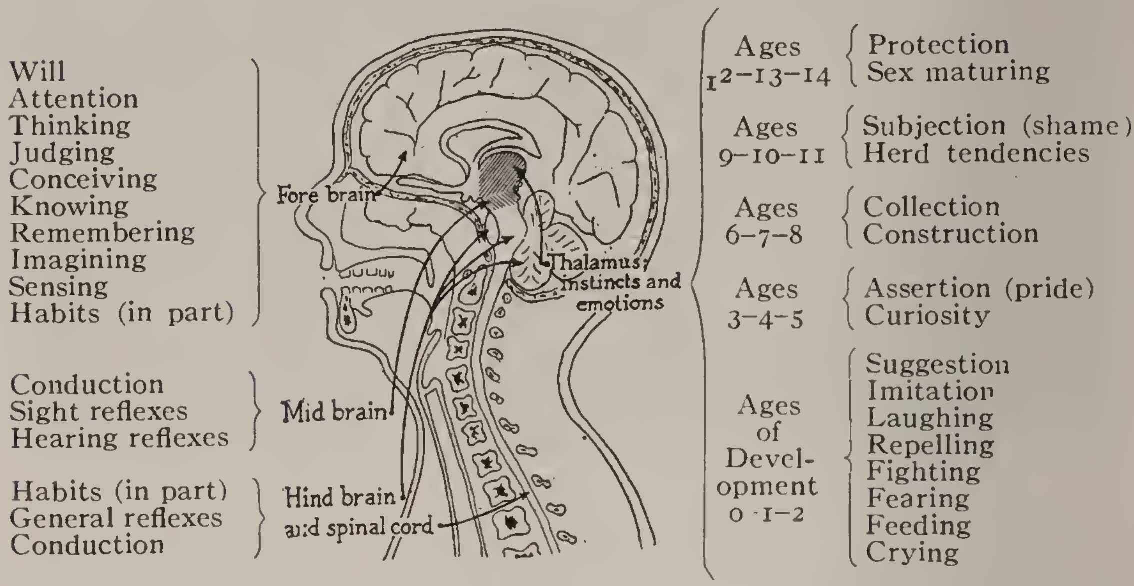

FIG. 80. The center of the nervous system, showing the parts and their functions, and the ages when the instincts develop.

B. When men get drunk, the alcohol affects the cerebrum first and dulls their wits in a little while. Why does a drunken man act like a lower animal?

C. When people grow very old, sometimes the upper part of the brain (the cerebrum) begins to go to pieces first; that is, it loses the impressions made by experience. Why do some very old people grow "childish"?

EXERCISE III. GENERAL QUESTIONS

1. What are the parts of the nervous system?
2. What are the two great functions of the nervous system?
3. What is the nervous system made up of?
4. What is a motor nerve?
5. What is a sensory nerve?
6. How heavy is the human brain?
7. What are its three principal parts?

8. How does the surface of the brain differ from the interior?

9. What is the use of the cerebrum?

10. What is the use of the cerebellum?

11. What is the use of the thalami?

12. What is the use of the medulla?

13. What is the use of the spinal cord?

14. Why are sleep and rest necessary?

15. How many hours of sleep should you have at your age?

16. What are some good rules for acquiring a helpful habit? For getting rid of a bad one?

17. If a child lets itself get angry easily all through childhood, what kind of disposition will it have when grown up?

18. If a boy or girl does not control his or her appetite when young, what is to be expected of the adult?

19. If a boy or girl is selfish in childhood, what will be true of the adult?

20. Why is it important that you learn to control your instinctive tendencies as early in life as possible?

21. What are some of the means that will aid you in controlling your instinctive or animal tendencies?

22. What are some good-health habits you have decided to practice as a result of your study of behavior and the nervous system?

STUDY FORTY-SIX

THE SENSES AND THEIR MEANING

A boy living on the Western plains had been warned many times by his parents to watch out for rattlesnakes. One day when he was going across a prairie to look after some cattle he suddenly noticed what he thought was a rattlesnake lying at his feet, and he turned instantly and ran toward home. The coiled-up thing on the prairie might have been a rope, a whip, or a harmless snake, but the boy did not stop long enough to see. He did not use his senses. He acted only instinctively. His thalami and his instincts had been implanted in him for just such a situation, and in this case may have saved his life.

But he had been given his senses and his enlarged cerebrum to help him get a fuller knowledge of what was around him, so that he need not always act instinctively. A closer observation and a larger experience with coiled-up things might have saved him a race for home and have restored his father's blacksnake whip lost on the prairie. You are now to study the senses with which he was endowed, and which he might have used with greater thoughtfulness.

Exercise I. Studies of Skin Senses and Muscle Senses

1. **The skin sensations.** To find out what are the four different kinds of sensations connected with the skin, make use of a pencil and pin as directed. Warm the pencil, and with its point explore a square inch on the front of your wrist to find tiny spots that seem warmer than other places. Make the pencil cold and hunt for corresponding cold spots. Have the pencil neither hot nor cold and try this time to find spots that are more

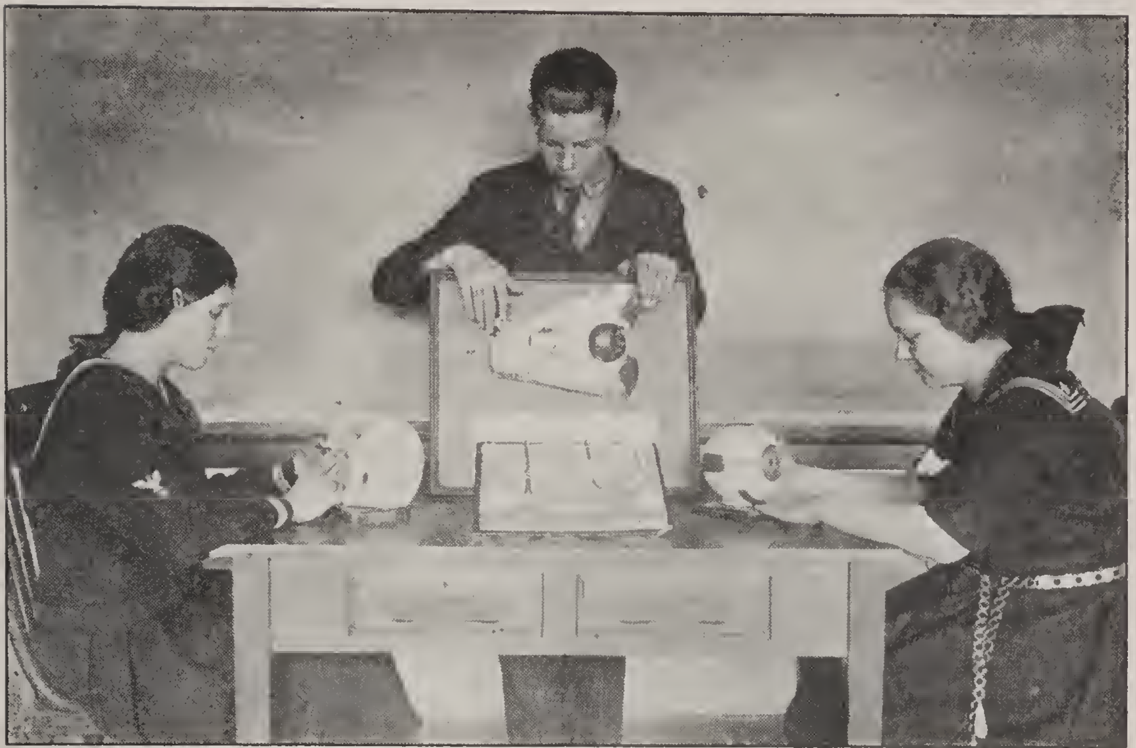

FIG. 81. Models of sense organs, the parts of which may be separated for study, will be found helpful.

sensitive to touch than other spots. Using a pin point, gently hunt for places a little more sensitive to pain than other places. What varieties of sensation have you found on a square inch of your skin?

2. **The muscle sense.** Put your open hand behind your head without touching it. You will know, of course, what shape your fingers are in, but now stiffen your fingers and see if there is a more certain knowledge of the position of your hand and fingers. What you get is a sensation of strain due to the pressure of the contracting muscles on the special nerve endings that carry the *muscle sense.* This is one of the most important of all your senses. Helen Keller, blind and deaf, depends upon this sense more than upon any other except touch for what she knows of the world in which she lives.

A. What is the muscle sense?

B. Of what use is it to you?

Exercise II. Smell and Taste

1. **Smell sensations.** After your teacher has put some odorous substances separately in cloth-covered, pasteboard boxes, see if you are able to say what the inclosed substances are.

A. How many substances were there to tell by the smell in your experiment with odors, and how many of these did you identify?

B. In your judgment, are the varieties of smell sensations fewer or more numerous than the skin sensations?

2. **The taste senses.** To get the experience of the four tastes the tongue can distinguish, put some sugar or candy at one place and another on the tongue to determine just where it can best tell sweetness. Similarly try a sour substance like "sour drops" of candy; a salty substance, such as common salt; and finally a bitter substance, such as quinine sulfate.

What different parts of your tongue seem best adapted to each of the elementary taste sensations?

Exercise III. The Ear and Hearing

1. **The outer ear.** The external ear consists of the organ at the side of the head commonly called the "ear" (the *auricle*), and the tube leading into the head (the *auditory canal*). In your notebook make a sketch of an auricle, labeling the outer rim *helix*, the inner ridge *antihelix*, the central depression *concha*, and the lower lobe *lobule*.

2. **Function of the outer ear.** Let some person standing several feet behind you call out a word with equal force under the following conditions: (1) while you hold your hands vertically, palms backward, one at each side of your head, and just in front of your auditory canals;

(2) while you hold your hands one just behind each auricle; (3) while your hands are removed. Repeat several times, if necessary, to make sure of the correctness of your answers to the questions that follow:

A. In what position of the hand can you hear best?

B. Why is this so?

C. What, do you judge from your experiments with your hands, is the use of your auricles?

D. What part of the auricle is most useful in hearing?

3. **The whisper test for hearing.** With pupils seated so the right ear is toward the tester, who stands 20 feet away, let the tester whisper with uniform loudness a series of 20 non-consecutive numbers between 10 and 99. Let the members of the group record the numbers as they understand them. The numbers are now to be read aloud by the tester, while the pupils set down the correct list and record the percentage of correct hearings.

The pupils are next to present their left ears to the tester for a similar test with a new series of numbers. Records are to be made as before.

Exercise IV. The Eye and Vision

1. **The coats of the eyeball.** To get a fair understanding of the eyeball, you should study its coats, one by one, from a real specimen of the eye of a large animal, such as a beef. There are three of these coats.

A. To study the external coat, clear away all muscles and connective tissue from the eyeball down to the tough gray outside portion, known as the *sclerotic* coat, which covers the rear four fifths of the eyeball. Now make a small cut in the center of the rear part of the sclerotic coat, being careful not to cut through into the black coat beneath, if this can be avoided. With pointed scissors

make a cut forward to the center of the clear or colored part of the eye, holding the scissors in such a way that the under point is kept against the underside of the outer coat, thus preventing the puncturing of the black coat beneath. Now, similarly, make another cut forward at right angles to the first cut, so as to make a sector of the sclerotic coat, which is then to be peeled forward. The front one fifth of the outer coat of the eye is called the *cornea*. How does the cornea differ in three ways from the sclerotic coat?

B. The middle coat of the eyeball is made up of three parts. The first of these is the black coat underlying the sclerotic, called the *choroid* coat. By pulling at it with pliers (in a way not to break the gray *retina* beneath) discover its thickness and structure, as compared with the thickness and structure of the sclerotic coat. Note two ways in which the choroid coat differs from the sclerotic coat?

The second portion of the middle coat of the eyeball is called the *iris*. It is a circular membrane with a hole in the middle, and it may be seen attached to the forward border of the choroid coat. Describe the iris and the *pupil*.

The third portion of the middle coat of the eyeball may be seen by tearing away the exposed part of the iris, and finding back of it numerous black folds known as the *ciliary processes*. Together these make a circular, fringe-like belt behind the iris. Record in your notebook what you have learned about the ciliary processes.

C. The inner coat of the eyeball is called the *retina*. Carefully pull away the black middle coat of the eye from rear to front of the opening you made, so as to expose more fully the delicate, gray retina. Only patches of

it may be left, unless the dissection has been very skillfully done.

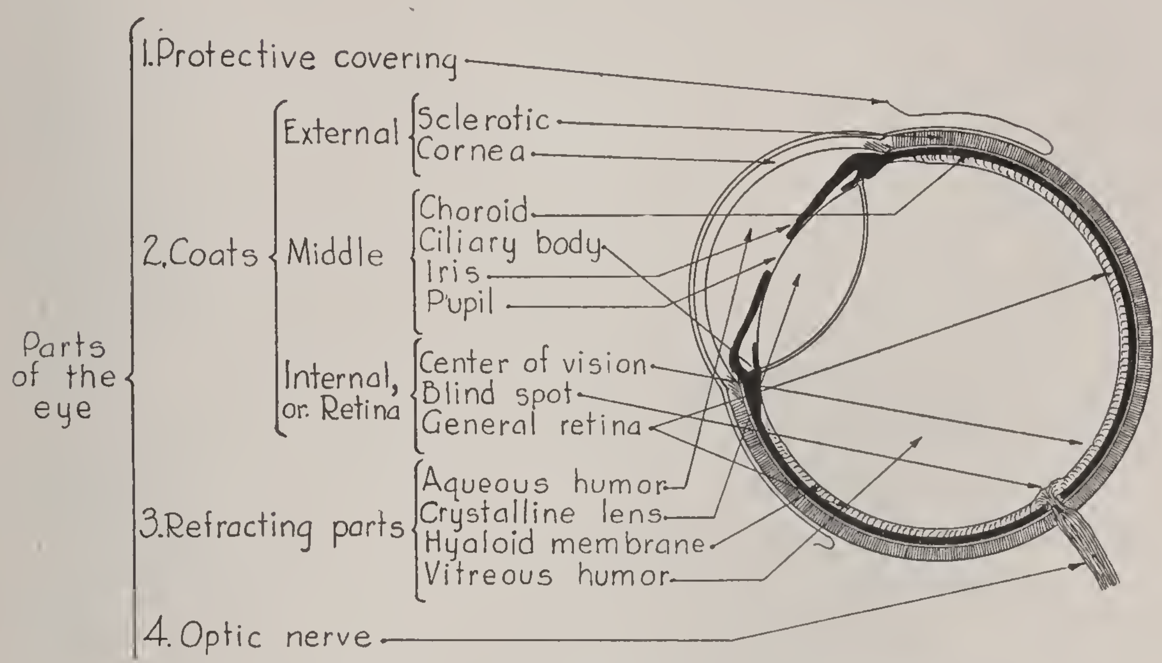

FIG. 82. The parts of the eye.

A. Does the retina go as far forward as the choroid coat does?

B. Is the retina as thick and strong as the choroid coat is?

C. Do you find any signs of blood vessels in the retina?

D. Emptying the contents of the eye into a small dish and turning the coats inside out, to what part of the eye do you find the retina attached, as it now hangs down from this point of attachment?

E. The attached part of the retina is known as the *blind* spot. What is the relation of the retina to the optic nerve and of the optic nerve to the blind spot?

2. The inner parts of the eye. You now turn to the study of the inner parts of the eyeball. The larger, jelly-like mass thrown out in the previous study is the *vitreous humor*. Handle it, cut it, and observe its outer surface

known as the *hyaloid membrane.* Write a brief description of the vitreous humor.

The lens-shaped body lying at one side of the vitreous humor, and surrounded by black radiating marks left by the ciliary processes, is the *crystalline lens.* With sharp-pointed scissors, cut the hyaloid membrane around the border of the lens and remove the lens from the vitreous humor. Try using the lens as you would a simple microscope. Write a brief description of the crystalline lens.

There is a liquid (*aqueous humor*) normally lying between the lens and the cornea. It escaped when you cut the cornea and was blackened by coloring from the middle coat of the eyeball. Did you see any aqueous humor?

3. **Nearsightedness, farsightedness, and normal vision.** Place 20 feet away in a good light, a Snellen or other eye-test chart, such as may be had of a physician. Read the card with one eye, and record the letters in the lowest line you can read without strain. Note the number that stands at the left of the lowest line read, and use it as the numerator of a fraction whose denominator is 20 (the 20 feet you stand from the chart). If the value of your fraction is one, the vision is normal. If it is more than one, farsightedness (*hypermetropia*) is indicated. If the value is less than one, nearsightedness (*myopia*) is indicated. Proceed similarly with the other eye. Record results and conclusions.

A. What is the strength of your right eye?

B. What is the strength of your left eye?

4. **Astigmatism.** Substitute for the Snellen or other card, a test card having radiating lines. Look with each eye separately, and note whether any of the radii appear darker than others. If any radii appear gray, indicate which ones they are by giving the number appearing at

the ends of the lines. To normal eyes the lines all look equally black. If they appear considerably different, the eye is *astigmatic*.

A. Does your right eye show astigmatism?

B. Does your left eye show astigmatism?

5. **Review.** Recall or reproduce the studies of the image made in an eye when seeing, as that experiment is described in Study Thirteen.

Exercise V. General Questions

1. What are the five most important *groups* of external senses?

2. What are the two most important *groups* of internal senses?

3. How many different senses have you studied?

4. What are four different sensations you get through the skin?

5. What are four different sensations you get through the tongue?

6. How is the sense of smell stimulated?

7. Why is the sense of smell an important one?

8. What are the three main parts of the ear?

9. What is the purpose of the outer ear?

10. What are three important structures in the middle ear?

11. What are the three important structures in the inner ear?

12. How does a sound wave start a message to the brain?

13. Why is earache a disease that may prove dangerous?

14. Why should you try to heal up a "running ear" quickly?

15. Mention four causes of ear trouble.
16. What excites the optic nerve?
17. How is the eye protected?
18. How is the eyeball directed?
19. Label the important parts of the eye in the copy of the diagram, Figure 82, which you are to draw in your notebook.
20. What is the iris of the eye for?
21. What is the pupil of the eye for?
22. What is the crystalline lens for?
23. What is meant by accommodating the eye?
24. What is myopia?
25. What is hypermetropia?
26. What is astigmatism?
27. Why should people with defective vision wear glasses?
28. What are some common diseases of the eye?
29. How should the light fall on the page when reading?
30. How can one best rest the eyes?
31. What are several important habits with respect to the care of sense organs?

STUDY FORTY-SEVEN

HEALTH PROBLEMS

In Part Two of this book you considered the problem of germs and germ diseases. In Part Three you have had a simple introduction to the great subject of physiology, the science which deals with the normal workings of the cells. Here you have learned that unless all the cells do their share of work in the general division of labor, some difficulty will arise in the human mechanism. If a man is suffering from indigestion or any other disease not due to germs, he is said to have a *physiological disease*. Physiological diseases in large part account for the deaths not due to germs.

Some interesting problems arise in connection with what are called *mortality statistics*, that is, statistics of the *kinds* of diseases and the *number of people* dying from each. For the year 1920 in those parts of the United States known as the registration area, it was reported that

FIG. 83. Sixth-grade pupils who have just received their Health Certificates for doing their health chores for six weeks

over 800,000 people had died, and that 387,000 of these deaths were from germ diseases. These statistics do not cover those parts of the country — over two-fifths of it — from which no reliable statistics are obtained.

Exercise I. Studies of Mortality Statistics

1. **Causes of deaths in the United States.** Get a late copy of the *World Almanac*, the *Chicago News Almanac*, or the latest volume of *Mortality Statistics* issued by the Census Bureau, and find the figures for filling in the table that follows:

DEATHS IN REGISTRATION AREA	TOTAL	PER CENT
Germ diseases	....	....
Physiological diseases	....	....
Miscellaneous diseases	....	....
Accidents	....	....
Old age	....	....
Total	....	....

2. **Causes of deaths in your own state.** Get a copy of the Health Report from your State Health Commissioner; and from it fill out a table on deaths in your own state. Let the table be like the one for deaths in the registration area.

3. **Causes of deaths in your own county or city.** From your State Health Report, fill out a table on deaths in your own county or city.

4. **Principal germ and physiological diseases in your state.** From your State Health Report get the mortality statistics for the twenty principal *germ* diseases and list them in a column on the left-hand side of your notebook. To the right of this column, list the twenty principal

physiological diseases in order, from greatest to least. If you are in doubt how to classify any particular disease, see an encyclopedia, or consult a local physician or the school nurse. (See also Byrd's *Forty Notifiable Diseases.*)

5. Principal germ and physiological diseases in your county or city. In your State Health Report check up the number of deaths caused by diseases that you think are preventable, and determine what per cent this is of the total number of deaths. Do the same for the report of your county or city. What percentage of deaths has been needless in your state and county or city in the last year?

EXERCISE II. GENERAL QUESTIONS ON MORTALITY STATISTICS

1. About how many people die every day in your state (*a*) from all causes, and (*b*) from preventable diseases?

2. About how many people die every day in your county or city from (*a*) all causes, and (*b*) from preventable diseases?

3. How many minutes are there, on the average, between the deaths of every two people dying from tuberculosis in the registration area of the United States?

4. What do you think is the principal reason so many people die needlessly in the United States every year?

5. How many people are sick at any one time in the United States?

6. About what proportion of these are needlessly sick?

7. What is the present average length of life in the United States?

8. How much greater is this average than it was twenty years ago?

9. To which is the gain more probably due, the conquest of germ diseases or of physiological diseases?

10. Has it been due more to the saving of child life or of adult life?

11. What is the length of your own life expectancy now?

12. What may you do to extend your life beyond your present expectancy?

13. What is your score for hygienic living as determined from Appendix C?

A FINAL WORD WITH THE BOYS AND GIRLS

When you think of that great American, Theodore Roosevelt, visions of the rough rider, the hunter, and the explorer naturally come to mind. And with these, of course, go the idea of his vigor, force, enthusiasm, and physical fitness. It is hard to think that when Roosevelt was a boy, he was "pig-chested and asthmatic" as he himself has said. Indeed, his fight with asthma was the lognest and hardest fight he ever made. His body was frail, but he had a conquering spirit, and he was determined to be strong like other boys.

On the wide back porch of the Roosevelt home in New York City, a gymnasium was fitted up, and the boy resolutely set himself to the task of gaining health and bodily vigor. "I made my health what it is," he has said. "I determined to be strong and well and did everything to make myself so. By the time I entered Harvard, I was able to take part in whatever sport I liked. I wrestled and sparred and ran a great deal, and although I never came out first, I got more out of the exercise than those who did, because I immensely enjoyed it and never injured myself."

Health is indeed a controllable condition, in considerable degree. Even though you may have nearly perfect health at the present time, you may lose this treasure; but you may do much to retain it, and even to regain it if lost. However, retaining is surer than regaining. You have been given facts in this book which have been found out for you at great cost of life and sacrifice. Whether or not you profit by these facts is for you to determine.

The author wishes you a long, healthy, happy, and useful life, and will consider himself rewarded for his labors if he has been able in some degree to help make these things possible for you.

APPENDIX A

A PLAN FOR A HEALTH CLUB

THE idea of good health is not an object of natural interest among the immature. It therefore becomes necessary to set up some form of artificial motivation that will stimulate the exercise of desirable health practices until habituation is complete. Inasmuch as boys and girls from nine to fifteen years of age are in what is known as the "gang and clique period," it is not difficult to interest them in the organization of clubs or societies. Probably the best means yet devised for the actual setting up of good-health practices among school pupils is that of organizing Good Health Clubs.

The club idea has been carried to a high state of perfection by the Modern Health Crusade with its national program of health instruction in schools. Its *Manual for Teachers* should be in the hands of every teacher, and may be secured from the National Tuberculosis Association, 370 Seventh Avenue, New York City.

The following constitution for a health club is modified from the one prepared by the Modern Health Crusaders and from the plan drawn up for the pupils of the Louisville, Kentucky, schools by Miss Emma Dolfinger. It is submitted for the use of those who do not care to enter the larger organization. The "Record Chart of Health Chores" found in Appendix B is intended to go with this constitution.

A Proposed Constitution for a Health Club

ARTICLE I. NAME

The name of this Club shall be ———.

ARTICLE II. OBJECTS

The objects of this Club shall be as follows:

1. To aid its members in the establishment of good-health habits.
2. To spread the knowledge of health among the members and others of the community.
3. To keep good health through athletic and other kinds of exercise.
4. To assist the teacher and other school officers in their work for the health of all school pupils.

5. To improve the sanitary conditions of our homes, our school and our community.

6. To be loyal to the Club and its stand for clean thought, speech, sports, and bodies.

ARTICLE III. MEMBERSHIP

SECTION 1. *Who may join.* Candidates for membership must know the Twelve Health Chores (see Appendix B), and must be able to show a record of having practised them at least two weeks with a completeness of at least three fourths.

SECTION 2. *Becoming a member.* An eligible candidate may be admitted to membership on assenting in open meeting, and with uplifted hand, to the following pledge stated by the presiding officer or organizer: "Do you promise to try to win and keep good health, to be honest in all your records and reports, and to be loyal to all the objects of the Club, in order that your country may have stronger and better men and women? If so, answer,'I do.'" After the assent, the officer will then say, "You may now sign the Club Roll as a further evidence of your seriousness of purpose." After the roll has been signed, the badge of membership, always the property of the Club, shall be attached to the new member.

SECTION 3. *Duties of members.* It shall be the duty of each member to maintain a record of the daily performance of at least three fourths of the Health Chores; to be active in the support of the objects of the Club; and to obey all the rules that the Club may adopt at its regular meetings in which at least ten members are present. Willful neglect of these duties for a month or more, shall subject the offending member to expulsion from the Club and to the forfeiture of his badge.

SECTION 4. *Honors.* A member continuing in good standing and showing a record of at least three fourths of the health chores performed for four weeks, shall be given one star to wear on his badge; performed for eight weeks, two stars; performed for twelve weeks, three stars; performed for sixteen weeks, four stars; and for each additional month thereafter, an additional star.

ARTICLE IV. OFFICERS

SECTION 1. *List of officers.* The Officers of this Club shall be an adult Adviser, a President, a Vice President, and a Secretary, each selected for a term of twelve weeks. There shall also be a Health Officer, elected for a term of four weeks.

SECTION 2. *Duties of officers.* The Adviser shall attend each meeting of the Club, or be represented by another responsible adult. He

shall act only in an advisory way. The duties of the President, Vice President, and Secretary shall be those common to such officers in other societies. The Health Officer shall keep posted on the blackboard of the schoolroom, or elsewhere, the temperature of the schoolroom at various hours of the day and shall try to secure a constant temperature of 68° F. He shall see that the schoolroom is aired at proper times, and shall perform such other duties as are from time to time assigned to him.

ARTICLE V. MEETINGS

SECTION 1. *Time of meetings.* The Club shall hold regular meetings once a month. Special meetings may be held at such other times as may be voted at a regular monthly meeting or called by the Adviser.

SECTION 2. *Contesting groups.* The Club membership shall be divided by the Adviser into two as nearly equal groups as possible, which shall take turns in providing programs for the meetings and may engage in health-chore and other health or membership contests. The groups may work on various projects, such as entertainments, dramatizations, toothbrush drills, first-aid exhibitions, sanitary-district supervision, anti-rat, anti-fly, anti-mosquito, or other campaigns.

SECTION 3. *Procedure for a meeting.*

1. Meeting called to order by the presiding officer.
2. Roll called by Secretary, who records the total number of health chores performed since the last meeting as reported by each member when his name is called.
3. Reading and adoption of the minutes of the last meeting.
4. Reports of committees and attention to unfinished business.
5. Taking up new business, awarding stars, electing officers, etc.
6. Admission of new members into the Club.
7. Program of about twenty minutes' duration on some health topic.
8. Adjournment.

ARTICLE VI. AMENDMENTS

This constitution may be amended if an announcement is made at a regular meeting and voted on at the next regular meeting with at least twice as many voting for it as against it.

APPENDIX B

Health Chores and Record Chart

1. WATER

Drink one or more glasses of water with each meal, but not to wash down the food.

2. MILK

Sip at least two glasses of milk each day, but drink no tea or coffee.

3. FRUIT

Include fruit or leafy vegetables in the day's diet and chew all food thoroughly.

4. TEETH

Brush teeth thoroughly after rising and before retiring, at the least.

5. PLAY

Play vigorously, breathing fresh air deeply for at least half an hour.

6. BOWELS

Have bowel movement at least every morning.

7. SLEEP

Retire before 10 P. M. and rise after 7 A. M., sleeping with windows open.

8. TIDINESS

Clean the finger nails in the morning and always wash the hands before eating.

9. BATHING

Take a full bath two or more times a week.

10. MOUTH AND NOSE

Keep unclean fingers and other unclean things away from mouth and nose.

11. HANDKERCHIEFS

Carry and use handkerchief properly in sneezing, coughing, and cleaning the nose.

12. MENTAL ATTITUDE

Try hard to be neat, happy, helpful, generous, and fair all through the day.

My Record of Chores Performed

Note. The form of the Record Sheet is indicated below. When the sheet is prepared for use, it should be extended to cover the rest of the months of the school year and also to cover each of the twelve Health Chores indicated above. Make an X in each day's square for each chore done; half an X if chore is half done.

Chores	Weeks	October							November							December						
		S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
	First																					
1	Sec'd																					
	Third																					
Water	F'rth																					
	Fifth																					
	First																					
2	Sec'd																					
	Third																					
Milk	F'rth																					
	Fifth																					
	First																					
3	Sec'd																					
	Third																					
Fruit	F'rth																					
	Fifth																					

APPENDIX C

A SCORE CARD FOR HYGIENIC LIVING

(Slightly modified from the Curtis High-School Score Card, New York City)

Note. Grade yourself on each of the items below, giving yourself as many points in proportion to the standard as you think you ought to have. Add the right-hand column, containing your credits, to find your total percentage of hygienic efficiency.

What is your grade on hygienic habits?

	POINTS	CREDITS
Sleeping in the open, or with bedroom windows open	6	...
Mattress (no feathers)	1	...
Small pillow	1	...
Bedclothing aired	1	...
Arising regularly at 7 A. M. or earlier	2	...
Light exercise for at least five minutes on arising	2	...
Cold bath every morning, unless ill	7	...
Hair brushed 25 strokes or more daily	2	...
Teeth cleaned at least morning and night	6	...
Individual towel	1	...
Glass of water on rising	1	...
Hygienic breakfast, thorough chewing	2	...
At least one item from each of three classes of food: Class I, fruit; Class II, bread, cereal, baked potatoes; Class III, eggs, bacon, milk, fish, cheese	3	...
No candy or other food between meals	2	...
No active exercise for 20 minutes after a hearty meal	2	...
Carry books and small packages at arm's length and change hands often	1	...
Use fully 20 minutes for noonday lunch	3	...
Hygienic noonday lunch, thorough chewing	2	...
At least one item from two classes: Class I, bread and butter, crackers; Class II, milk, soup, meat	6	...

	POINTS	CREDITS
Two glasses of water at lunch time or in afternoon	2	...
Vigorous exercise, 30 minutes at least	6	...
Rest 10 minutes before dinner (or supper)	1	...
Hygienic dinner (or supper)		
Attractive table, 1; chew well, 2; eat moderately, 2; at least one item from these three classes: Class I, potatoes, bread, macaroni, rice; Class II, soup, stew, roast, baked beans, cheese; Class III, fruit, vegetables, 3	8	...
Study or read at least 2 hours	4	...
Light behind, above, and sufficient	3	...
Retire regularly by 10 P. M.	5	...
Glass of water before retiring	1	...
Clean hands, face, and mouth before retiring	2	...
Hygienic clothing	8	...
Correct posture	3	...
Hands and finger nails kept clean at meals	3	...
All meals at reasonably regular times	3	...
Total	100	...
For use of coffee or tea deduct 2 points per meal		
For use of alcohol or tobacco deduct 15 points each		
Total minus deductions		

APPENDIX D

APPARATUS, MATERIALS, AND SUPPLIES FOR THE COURSE

I. GENERAL STATEMENT

THE following lists include articles that may well be provided rather early in the course for use at any time. Many of the items called for in the various studies of the text will be needed only for temporary use. These may be assembled from local resources at the time a study is taken up, and are not listed here. Money from the Junior Red Cross funds may legitimately be used in purchasing supplies. If such a fund is not available, a few health programs, dramatizations, or other pupil entertainments, will serve as means to secure the funds necessary for the successful teaching of hygiene. Once the public is educated to this need, boards of education will readily supply the necessities for such a course.

II. EMERGENCY OUTFIT FOR THE SCHOOLROOM

The following materials should be a part of every rural and city school equipment for use in first-aid work, and can be had from almost any drug store:

1 dozen bandages, 1 inch wide
1 pound absorbent cotton
1 yard of sterile gauze
1 roll of zinc oxid adhesive plaster, 1 inch by 10 yards
1 ounce flexible collodion, with brush to apply
4 ounces of aromatic spirits of ammonia
6 ounces of carron oil (for applying to burns)
1 box of borax
1 ounce of oil of cloves
1 paper of safety pins, small and large
1 copy of Lynch's *American Red Cross Abridged Textbook on First Aid.* P. Blakiston's Sons & Co., Philadelphia

III. SPECIAL MATERIALS FOR PART ONE

1 weighing scales and 1 tapeline
1 homemade spirometer (see Figure 10)

1 piece of rubber dam, 6 inches by 6 inches
4 milk bottles (pints)
Several small candles
1 pint of limewater
1 full set of extracted teeth got from a dentist
2 dozen 6-inch test tubes, or small bottles
8 ounces of hydrochloric acid
1 square foot each of cotton, linen, silk, and thin wool cloth
1 big sheet or several "books" each of blue and of red litmus paper
1 small bottle of alum crystals
1 dairy thermometer
Several simple microscopes, or reading glasses
1 small bottle of saturated water solution of copper sulfate
1 pint of half water and half glycerine solution of ferric chlorid
1 small bottle of water solution of tannic acid
1 preserved specimen of cow's, sheep's or dog's brain
1 Snellen's or other test card for vision
A quantity of bandaging materials

IV. SPECIAL MATERIALS FOR PART TWO

4 ounces of powdered sugar
2 dozen 6-inch test tubes or small bottles
Several simple microscopes or reading glasses
1 compound microscope for temporary use
8 ounces of formalin
2 ounces of oil of cloves
4 ounces of hydrochloric acid
4 ounces of ammonia water
1 big sheet or several "books" each of red and of blue litmus paper
4 ounces of small scales of shellac
5 cents' worth of quicklime for making limewater
1 small bottle of chlorid of lime
Ten cents' worth of flowers of sulfur
Small bottle of hydrogen peroxid
1 pint of denatured alcohol
A bottle of 5 per cent. solution of carbolic acid
1 microscopic mounting of a trichina worm

V. SPECIAL MATERIALS FOR PART THREE

All the materials called for in Part One
Several alcohol lamps with wicks
1 pint of denatured alcohol
4 ounces of tincture of iodine
2 ounces of sulfuric acid
1 ounce of urea crystals
1 package of pulverized cornstarch
1 carbon-dioxid generator (see Figure 58)
1 carbon-dioxid tester (see Figure 58)
1 syringe bulb, and rubber tubing 2 feet long
1 balancing apparatus (see Figure 67)
1 ventilation cabinet (see Figure 70)
1 fatigue apparatus (see Figures 74 and 75)
1 compound microscope with slides and cover glasses

APPENDIX E

REFERENCE PAMPHLETS FOR PUPILS AND TEACHER

(For use with "Questions for Investigation")

1. At the beginning of the course, send to the Metropolitan Life Insurance Company, New York City, for their collection of posters, charts, and booklets on health, which they send out free.

2. Send also to the Bureau of Education, Department of the Interior, Washington, D. C., for a set of their Health Education Series.

3. Send to the Superintendent of Documents, Washington, D. C., for his price list of government publications on health. Ask also for the latest list of Farmers' Bulletins.

4. Write to the Children's Bureau, Department of Labor, Washington, D. C., for its list of publications and for any free pamphlets which it may issue.

5. When you have received your list of Farmers' Bulletins, prepare a list of the numbers and titles of the following, with any additions and subtractions you may find desirable: Farmers' Bulletins Nos. 142, 206, 375, 391, 444, 449, 450, 602, 607, 671, 717, 734, 740, 754, 771, 824, 851, 896, 897, 926, 1069, 1097, 1110, 1136. The list of bulletins changes from time to time, and only a late list is dependable. Send your checked list to your Congressman, House Office Building, Washington, D. C., and if his supply is not exhausted he will send these to you free. If his supply is exhausted you may have to pay 5 cents apiece for the bulletins, to the Superintendent of Documents, Washington, D. C. But sometimes the bulletins can be had free directly from government bureaus.

6. Ask your State Commissioner of Health to send such posters and pamphlets as he has that will be of use in teaching hygiene.

7. Write to your State Veterinarian for pamphlets on tuberculosis in domestic animals, and any other health pamphlets he may have.

8. Secure the list of publications of the Tuberculosis Association of your state.

9. Write for the health publications of the International Harvester Company, Chicago.

10. Write for the poster pamphlet on Patent Medicines and Nostrums, which is issued by the American Medical Association, Chicago.

11. Write for the list of publications of the American Posture League, 1 Madison Avenue, New York City.

12. Write for the list of Health Material furnished by the Womans Press, 600 Lexington Avenue, New York City. The sets of charts on foot hygiene are very impressive and unusual. They cost only 20 cents.

13. The List of Publications of the American Social Hygiene Association, 370 Seventh Avenue, New York City, contains some invaluable suggestions on the subject of sex hygiene.

14. Other agencies having worth-while health material are; the American Child Hygiene Association, Washington, D. C.; the Child Health Organization of America, 370 Seventh Avenue, New York City; and the National Health Council, 17th and D Sts., Washington, D. C.

APPENDIX F

SUGGESTED REFERENCE BOOKS

(For use with "Questions for Investigation")

B. For Pupils of Intermediate Grades and Junior High Schools.

BAILEY, R. R. *Sure Pop and the Safety Scouts.* World Book Company, Yonkers, N. Y.

BYRD, HIRAM. *Forty Notifiable Diseases.* World Book Company, Yonkers, N. Y.

COLEMAN, W. M. *Handbook of the People's Health.* The Macmillan Company, New York.

CONN, H. W. *Physiology and Health* (Books I and II). Silver Burdette & Co., Boston.

DAVISON, A. *Health Lessons* (Books I and II). American Book Company, New York.

FERGUSON, H. W. *A Child's Book of the Teeth.* World Book Company, Yonkers, N. Y.

GULICK, I. H. *Gulick Hygiene Series* (6 books). Ginn & Co., Boston.

HAVILAND, M. S. *Modern Physiology, Hygiene, and Health* (3 books). J. B. Lippincott Company, Philadelphia.

HUTCHINSON, W. *Health Series* (Books I, II, and III). Houghton Mifflin Company, Boston.

JENKINS, H. D. *The Perfect Gentle Knight.* World Book Company, Yonkers, N. Y.

JEWETT, F. G. *Hygiene Series* (2 books). Ginn and Co., Boston.

RITCHIE, J. W. *New World Health Series* (3 books). World Book Company, Yonkers, N. Y.

WILEY, H. W. *Health Series* (Books I, II, and III). Rand, McNally & Co., Chicago.

WINSLOW, C. E. A. *Healthy Living* (Books I and II). Charles E. Merrill Company, New York.

II. For the Teacher.

ALLEN, W. H. *Civics and Health.* Ginn & Co., Boston. (441 pages.)

ANDRESS, J. M. *Health Education in Rural Schools.* Houghton Mifflin Company, Boston. (321 pages.)

Andress, J. M. *The Teaching of Hygiene in the Grades.* Houghton Mifflin Company, Boston. (177 pages.)
Ayres, M., William, J. F., and Wood, T. D. *Healthful Schools.* Houghton Mifflin Company, Boston. (292 pages.)
Bancroft, J. H. *The Posture of School Children.* The Macmillan Company, New York. (322 pages.)
Brewer, I. W. *Rural Hygiene.* J. B. Lippincott Company, Philadelphia. (233 pages.)
Broadhurst, J. *Home and Community Hygiene.* J. B. Lippincott Company, Philadelphia. (428 pages.)
Conn, H. W. *Bacteria, Yeasts and Molds in the Home.* Ginn & Co., Boston. (295 pages.)
Fisher, I., and Fisk, E. L. *How to Live.* Funk & Wagnalls, New York. (461 pages.)
Hoag, E. B., and Terman, L. M. *Health Work in the Schools.* Houghton Mifflin Company, Boston. (321 pages.)
Hough, T., and Sedgwick, W. T. *The Human Mechanism.* Ginn & Co., Boston. (572 pages.)
Hunter, G. W. *A Civic Biology.* American Book Company, New York. (432 pages.)
Hutchinson, W. *Preventable Diseases.* Houghton Mifflin Company, Boston. (442 pages.)
Keen, W. W. *Medical Research and Human Welfare.* Houghton Mifflin Company, Boston. (160 pages.)
Moore, H. H. *Keeping in Condition.* The Macmillan Company, New York. (137 pages.)
Stiles, P. G. *Human Physiology.* W. B. Saunders Company, Philadelphia. (421 pages.)
Terman, L. M. *The Hygiene of the School Child.* Houghton Mifflin Company, Boston. (417 pages.)
Towns, C. B. *Habits That Handicap.* The Century Company, New York. (223 pages.)
Walters, F. M. *Principles of Health Control.* D. C. Heath & Co., Boston. (496 pages.)
Williams, J. F. *Personal Hygiene Applied.* W. B. Saunders Company, Philadelphia. (412 pages.)

A full index that will serve as a comprehensive key to the contents of this book will be supplied when the final edition is issued. It has been thought advisable to dispense with an index in this preliminary edition.